TETRA TECH

Remediation Work Plan

Wolcott Street Acid Sludge Remediation Project

Former Lobell Refinery Orphan Site 57.004 Casper, Wyoming

Prepared for:

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Solid and Hazardous Waste Division

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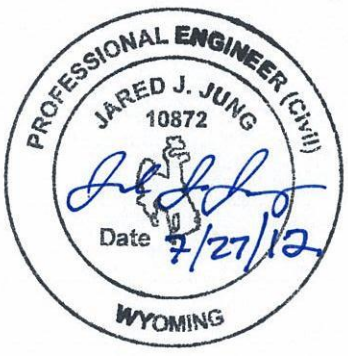

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1.0 INTRODUCTION

The Wolcott Street Acid Sludge Remediation Project, which is part of the former Lobell Refinery, is located in downtown Casper. The remedial area, as defined by Wyoming Department of Environmental Quality (Wyoming DEQ), extends approximately 55 feet east across South Wolcott Street and approximately 170 feet north from East Collins Drive towards the Rails to Trails pathway. The purpose of the remediation project is to remove and remediate the waste material (acidic hydrocarbon waste) and impacted soil that occurs beneath the Wolcott Street area.

Wolcott Street has experienced acidic petroleum surface seeps that have migrated upward from the subsurface to the street and bordering sidewalk areas for several years. The source of the seep material appears to be either from the former Lobell Refinery storage tanks or from a reported oil pit subsequently filled with soil. The seeps are comprised of a tar-like material and lesser amounts of a clear liquid. These materials have been found to exhibit pH values of less than 2 standard units (s.u.). The low pH of the seep material presents a public exposure hazard via dermal contact.

The remedy selected by the Wyoming DEQ to remediate the acidic hydrocarbon waste material and impacted soil (waste/soil) at the Wolcott Street portion of the former Lobell Refinery Orphan Site 57.004 (Site) is excavation, on-site pH neutralization, and transportation for off-site disposal of the treated material to the Casper Landfill as petroleum contaminated soil (PCS).

The known contaminants of concern identified at the Site from previous investigations at the former Lobell Refinery include low pH waste material and total petroleum hydrocarbon diesel range organics (TPH-DRO). The Site remediation is intended to remove the source of acidic hydrocarbon seeps migrating to the Wolcott Street surface and therefore eliminate the primary exposure pathway (dermal contact) and preclude other potential exposure pathways from becoming active.

1.1 Scope of Work

The scope of work (SOW) for this project will consist of the following general tasks:

- Remediation Pilot Test

- Pre-mobilization:
  - Review existing Site data
  - Review plans and permit requirements for performing work
  - Conduct kick-off meeting with stakeholders
  - Conduct a preconstruction meeting
  - Community outreach

- Mobilization
  - Mobilize personnel, equipment, and subcontractors
  - Perform site utility clearance and obtain a street cut permit for excavation area

- Site Setup
  - Site security and access controls
  - Traffic and pedestrian controls
  - Storm Water controls
  - Define exclusion, decontamination, and loading areas
  - Sanitary facilities

- Remediation
  - Pavement removal
  - Waste excavation, removal, and management
  - Remedial treatment
  - Monitoring and verification and confirmation sampling
  - Transportation and disposal

- Site Restoration
  - Backfill, road base, compaction
  - Sidewalk, curb, and gutter replacement (if necessary)
  - Final Site cleanup
  - Demobilization

1.2 Project Goals and Objectives

The goal of the remediation project is to eliminate the surface exposure pathway of the acidic hydrocarbon waste migrating to the Wolcott Street surface. The objectives of the project are to:

- Excavate the waste source material and transfer to the on-site treatment area for neutralization;

- Treat the waste on-site to meet Casper Landfill disposal requirements;

- Transport treated waste off-site for disposal as petroleum contaminated soil (PCS) at the Casper Landfill;

- Backfill the excavation and restore the Site.

1.3 Project Organization and Points of Contact

The project organization will provide consistent management of the remediation activities.

Key project positions and responsibilities are identified below in **Table 1.3-1**.

Table 1.3-1 Key Project Team Members and Responsibilities		
Role	**Personnel**	**Responsibilities**
Wyoming DEQ Project Manager	Cindi Martinez	-Oversight of and coordination with Tetra Tech -Review all project planning documents and plans -Ensure project compliance with State requirements and guidance -Interface with members of the public and stakeholders
Tetra Tech Project Manager (PM)	Scot Keith	-Project Manager -Primary point of contact for Wyoming DEQ -Leads project team -Evaluate project status reports -Take appropriate action to address and resolve issues and problems
Tetra Tech Project Director (PD)	Dorothy Hall	-Provide technical support for project activities -Support Project Manager as necessary -Alternate Emergency Coordinator if necessary
Tetra Tech QA/QC Officer	Dorothy Hall	-Provide senior peer review
Tetra Tech Field Team/Remediation Supervisor (FT/RS)	Joe Scott	-Direct remediation treatment activities -Oversee subcontractor performance -Provide cost tracking information to the PM for construction activities
Tetra Tech Site Safety Coordinator (SSC)	Joe Scott	-Oversee site safety -Primary emergency response coordinator
Remediation Technician (RT)	Matt McCann	-Assist FT/RS in coordinating subcontractors activities and provide oversight of waste/soil excavation and treatment activities -Collect field measurements and verification and confirmation samples - Escort authorized Site visitors as requested -Back-up emergency response coordinator
Tetra Tech Corporate Health & Safety Program Manager	Yvonne Freix	-Consultation during unforeseen Site conditions and for complex health & safety issues -Review Site-specific Health and Safety Plan
Tetra Tech Engineering Support	Jason Stratton, PE	-Provide geotechnical and civil engineering consultation and oversight for engineering/ geotechnical work during all phases of the project

Table 1.3-1 Key Project Team Members and Responsibilities		
Role	**Personnel**	**Responsibilities**
	Jared Jung, PE	-Develop the project construction specifications -Provide construction oversight during backfilling and project closure
Materials Testing and Construction Services	Mark Peloquin	-Direct construction materials testing and preparation as necessary during the site restoration and construction project phase
	Nate Becker	-Provide construction oversight and construction materials testing during the construction and restoration phase of the project
Fuel Management Solutions (FMS) Construction Project Manager	Brad Nelson	-Project Manager for FMS -Manage Keyhole Technologies (traffic control contractor) -Manage proposed changes during construction Activities -Ensure health & safety procedures are followed during construction activities -Back-up Emergency Response Coordinator
FMS Foreman	Chad Federer	-Full time on-site Foreman for FMS -Direct all FMS on-site construction activities -Work closely with FT/RS to ensure smooth and efficient operation of on-site activities -Back-up Emergency Response Coordinator

1.4 Project Schedule

The on-site remediation activities are scheduled to commence on or about the week of July 30, 2012, per agreement with Wyoming DEQ and the City of Casper. Because warmer temperatures are required for asphaltic concrete paving, the remedial activities will need to be completed and the excavation backfilled in preparation of paving by the City of Casper prior to the end of September.

2.0 SITE CONDITIONS

2.1 Site Background

Background information pertinent to the remedial action includes the site-specific features, history of land usage, and previous investigations.

The following records were reviewed for background information concerning the Site history:

- Sanborn Maps;
- Historical topographical maps;
- Historical aerial photos;
- 1997 USEPA investigation report on the seep material;
- 2003 Inberg Miller Engineers subsurface investigation report;
- 2004 Gene R. George & Associates, Inc. preliminary assessment of investigation data;
- Historical local newspapers;
- A. J. Mokler's History of Natrona County;
- City of Casper files concerning Wolcott Street seeps.

2.1.1 Site History

The former Lobell Refinery site has been occupied by a number of different businesses and companies since the late 1800s. Pennsylvania Oil and Gas Company built and operated a petroleum refinery on the site from 1895 to 1903. The refinery was then purchased by Lobell, who operated it from 1903 until 1911. Sanborn Maps from that period indicate several tanks were located at the site extending across Wolcott Street.

Historical documents indicate there was an open oil storage pit located somewhere on the site, which was later filled in by the City of Casper because it was deemed a public health hazard. None of the historic maps showed the specific location of the oil storage pit. The filled in pit is a potential source of the surficial hydrocarbon seeps discovered along Wolcott Street.

Historical records also show that from 1911 to present time, the former Lobell Refinery site was owned and/or occupied by several different owner/operators, including but not limited to Midwest Refining Company, Stanolind Oil and Gas Company, Standard Oil Company, Chicago Northwestern Railway Company, and the Goodstein Property Trust. An electricity generation plant was once present on the northwest corner of the site, which was fueled first by coal and later by fuel oil. Northern Utilities also operated a warehouse located along the southern edge of the property.

According to historical records, a railroad siding was located along the north side of Collins Drive until it was removed between 1961 and 1967. The railroad track located along the north edge of the Wolcott Street Site is now a pathway as part of the "Rails to Trails" initiative to convert former railways into recreation areas. The former railroad tracks and historic activities associated with loading and unloading rail cars are also a potential source of Site contamination.

2.1.2 Previous Investigations

Several site assessments and limited environmental site investigations have been performed since 1995 to characterize the contamination in the area of the former Lobell Refinery, which

incorporates the boundaries of the Wolcott Street Site addressed in this Work Plan. The environmental studies conducted at the former Lobell Refinery have included projects completed under the direction of Wyoming DEQ, United States Environmental Protection Agency (USEPA), and private entities. These investigations are briefly summarized below.

- In 1995, two railroad tank car underground storage tanks beneath the northwest portion of the Site were emptied, cleaned and abandoned in place under the Wyoming Underground Storage Tank Program, Facility No. 4176.

- In 1997 URS on behalf of the USEPA investigated reports of seeps of viscous liquids rising to the ground surface through cracks in the sidewalks at the Site. Eight polynuclear aromatic hydrocarbon (PAH) compounds were detected at the Site. A report from URS Operating Services, Inc. (Denver, CO), entitled, "November 1997: *Analytical Results Report for Focused Site Inspection, J.H. Lobell Refinery Site, Casper, Wyoming, CERCLIS* ID# WY0001654391," was submitted to EPA Region VIII under Contract No. 68-W5-0031.

- A limited environmental site assessment was conducted in 2003 by Inberg Miller Engineers (IME). The report entitled, "*Subsurface Exploration Service, 421 South Center Street Property, Casper Wyoming,*" reported the presence of total petroleum hydrocarbon diesel range organics (TPH-DRO) in both shallow and deep soils in the eastern portions of the Site.

- In 2004, an additional site assessment was performed by Gene R. George & Associates, Inc. (GRGA). Activities included subsurface soil borings. Results confirmed the occurrence of weathered TPH-DRO in concentrations above the Wyoming DEQ Voluntary Remediation Program soil cleanup levels (2410 mg/kg to 8200 mg/kg) in the Site soils. The source of the weathered hydrocarbons was attributed to the former refinery operations from over 100 years ago.

- Limited site characterization studies were conducted at the Site by Tetra Tech in 2010 and 2011 and included subsurface soil sampling, direct push borings, test pit sampling, and assessment of the surface and subsurface acidic hydrocarbon seep material at Wolcott Street. Data collected was used to assess the vertical distribution of contamination in proximity to potential source areas. Measurable concentrations of PAH and TPH-DRO in the subsurface soil samples were detected. Analyses of the acidic hydrocarbon seep material showed concentrations of TPH-DRO and a pH range of 0.85 to 1.16 s.u. The results of the direct push soil boring investigation showed that the acidic hydrocarbon waste migrated upward along preferential pathways, but did not reveal the location of a single source area.

2.2 Site Description

The Wolcott Street remediation project Site is located in downtown Casper, Wyoming, and surrounded by commercial businesses. The vertical and lateral extent of the area impacted by the acidic hydrocarbon waste at the Site is not well defined. However, the presumed impacted area containing waste and impacted soil to be remediated (remedial area), as defined by Wyoming DEQ, extends approximately 55 feet east across South Wolcott Street and approximately 170 feet north from East Collins Drive towards the Rails to Trails crossing.

Figure 1 shows the Site location. The Wyoming DEQ estimates the volume of subsurface waste and impacted soil to be remediated is approximately 1,000 cubic yards.

Acidic hydrocarbon waste and impacted soil (waste/soil) will be excavated from the remedial area and treated on-site by pH neutralization using cement kiln dust (CKD). The dimensions of the on-site treatment area will be approximately 1.5 feet deep, 8 feet wide, and 50 feet in length. Excavated waste/soil will be placed in two 8-inch lifts in the treatment area with the neutralizing agent (CKD) sandwiched between each layer. These layers will then be blended with a RM-500 reclaimer to complete the waste treatment process. A more detailed description of the remedial activities is described below in Section 5.0, Remediation Activities.

Subsurface utilities located within the remedial area include the Source Gas main, a Century Link communications duct bank (fiber optic line), and Joshua's Storehouse sewer service line. No other utilities lines in the remedial area have been reported. Waste/soil excavation within close proximity to these subsurface utilities may be restricted by the utility owner. Excavation may also be limited by nearby building structures.

3.0 PRE-REMEDIATION ACTIVITIES

3.1 Remediation Pilot Test

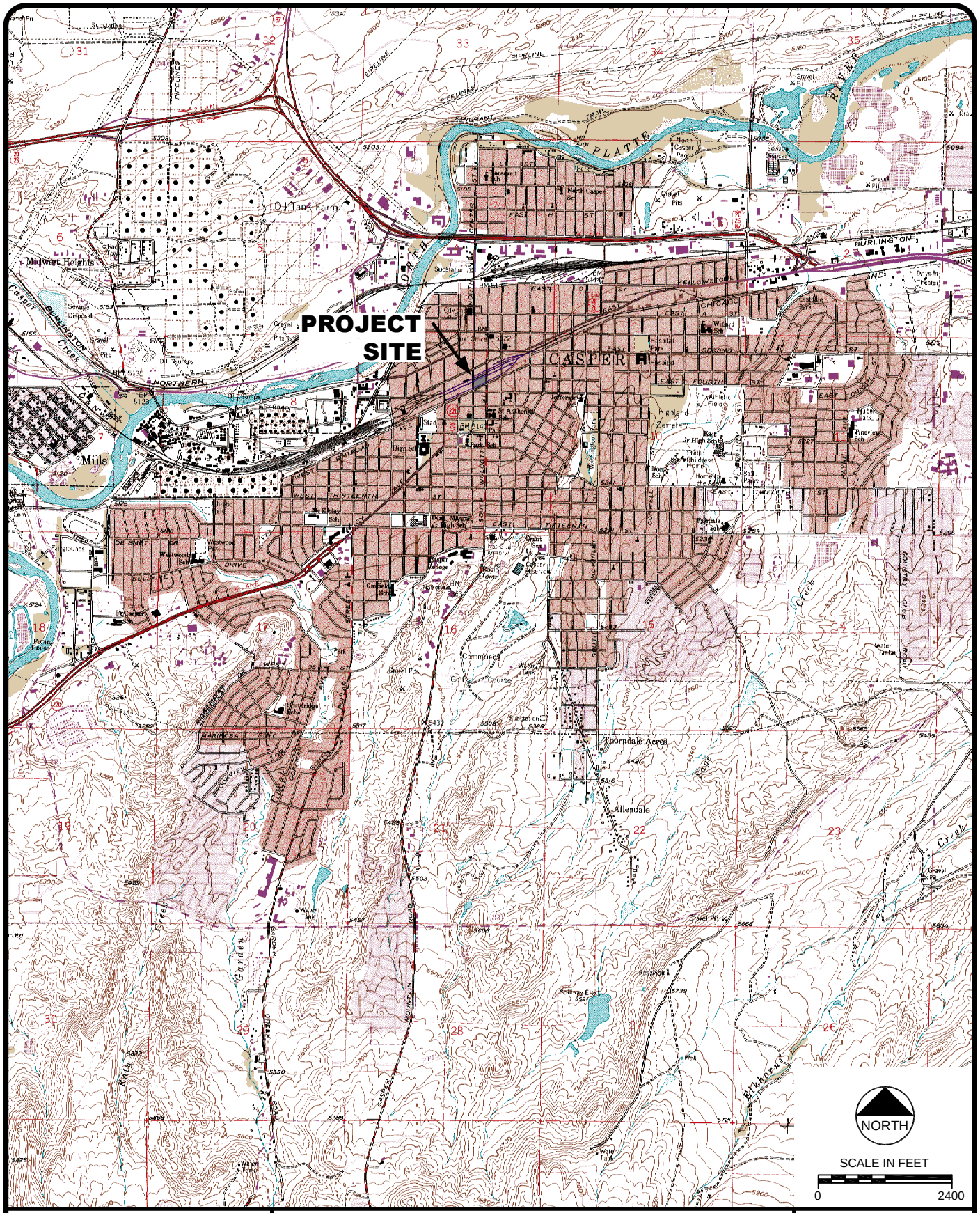
A Pilot Test was conducted to determine the most effective neutralizing agent and optimal operating parameters for the full scale remediation process. Three neutralization agents were evaluated for use in full scale treatment – fly ash, cement kiln dust, and precipitated calcium carbonate. Based on good mixing properties, rapid neutralization, and treatment efficacy, pilot test results determined the cement kiln dust (CKD) was the most effective neutralization agent, using an application rate of ≤ 5 percent CKD by volume. The pilot test results are located in the project files and available for review upon request.

3.2 Site Visit and Stakeholder Meeting

A Site visit will be performed to assess current conditions prior to commencement of the remedial activities. Meetings were held on June 29, 2012, by Wyoming DEQ and Tetra Tech with stakeholders to coordinate details of their participation in project logistics and methods of communication. Meeting attendees included representatives from Source Gas, the City of Casper, Lai Thai, 12-24 Club, and Joshua's Storehouse.

3.3 Public Outreach

Wyoming DEQ conducted a public meeting on July 19, 2012, to communicate project remediation plans and to solicit input from the community. Outreach/educational materials consisting of graphical posters and a brochure were developed and presented at the public meeting. Any additional community outreach efforts requested by Wyoming DEQ will be coordinated with their Public Information Officer. The Wyoming DEQ published a public notice prior to the meeting in a newspaper of general circulation in Natrona County. The outcome of any public meetings and other relevant information will be posted on the Wyoming DEQ/Orphan Site Remediation Program website.



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Wyoming DEQ - Wolcott Street Remediation Project - Former Lobell Refinery
Casper, Wyoming

SITE LOCATION MAP

Project No.:	114-510538
Date:	June 2012
Drawn By:	MAT

FIGURE
1

3.4 Underground Utility Clearance

A utility locate through the Wyoming One-Call system will be conducted prior to commencement of the remediation activities in order to identify underground utility lines that may be encountered at the Site during excavation. The utility owners will be notified of the upcoming project work.

All utility lines within the excavation area will be properly protected according to the utility owner's specifications. No excavation or backfilling activities will be conducted within three feet of any utility lines without the presence of a utility representative.

3.5 Mobilization

The project team and subcontractor will mobilize and prepare the Site for work activities.

3.5.1 Site Personnel

The following personnel will be responsible for setting up temporary facilities and establishing work and support areas for the remediation project:

- Primary Subcontractor
- Field Team/Remediation Supervisor
- Site Health and Safety Coordinator

Subcontractor personnel will be mobilized to the Site and will include the following:

- Equipment Operators
- Construction Foreman
- Truck Drivers

3.5.2 Equipment

The following construction equipment will be utilized during excavation and remediation activities. Additional equipment may be brought on-site as necessary.

- RM-500 reclaimer
- Trackhoe excavator
- Backhoe
- Skid Steer Loader
- Front end loader

3.6 Site Set-Up

3.6.1 Pre-Construction and Site Preparation

The following pre-construction activities will be performed:

1. All applicable and necessary permits will be obtained.

2. Documentation of the existing site features and locations will be conducted for purposes of proper restoration after excavation activities are completed. Photographs and use of a tape measure or GPS coordinates will be collected to locate and document pre-construction conditions.

3. A utility search will be conducted to identify underground utility lines at the Site. The utility owners will be notified of the project work.

4. Soil quality records of imported fill sources will be reviewed to determine suitability. If the existing records are insufficient, additional soil testing will be conducted.

5. A Traffic Control Plan will be prepared in accordance with local regulatory requirements.

The following Site preparation activities will be conducted prior to the remedial action:

1. The subcontractor will mobilize to the Site and prepare the Site for work activities.

2. The initial waste/soil excavation, support, and loading areas will be identified. It is anticipated that the boundaries of these areas will change as construction progresses.

3. The initial exclusion, decontamination, and support zones will be identified as needed and clearly marked. The exclusion zone (work zone) will include all areas of excavation, impacted waste/soil staging and treatment, and truck loading. If necessary, the decontamination zone will be located immediately adjacent to the exclusion zone for purposes of decontaminating personnel and equipment exiting the exclusion zone. The support zone will be located within the designated work area but outside the exclusion and decontamination zones. The support zone will be used to temporarily store equipment and vehicles (see Figure 3, Layout of Remedial Area).

4. Temporary sanitation facilities will be installed for use by the on-site personnel.

5. All identified utility lines in the work area will be properly protected according to the utility owner's specifications.

3.6.2 Site Security and Access Controls

Site access will be limited to authorized personnel during all remediation activities. A sign-in log will be maintained at the Site entrance for documentation of all personnel on-site.

Wyoming DEQ/OSRP project managers will be allowed escorted access to the remediation area as needed or as requested.

Because of health and safety concerns related to heavy equipment operations within the cramped and congested work area, all construction activities will cease whenever authorized visitors are in the work area in order to protect the health and safety of on-site workers and authorized visitors. All authorized visitors on-site in the exclusion zone must be escorted. The Health and Safety Coordinator will be responsible for maintaining the sign-in log and assigning an escort for the authorized on-site visitors.

Prior to commencement of work at the Site, the construction subcontractor will erect temporary security fencing, including a six-foot chain-link fence along sidewalks, barriers, and signs, to prevent unauthorized access into the exclusion zone.

During remediation activities, the Site will be secured to provide protection and safety of on-site personnel and equipment and to prevent unauthorized access. The temporary security fence will be located to allow for adequate room to operate excavation, treatment, loading, and hauling equipment and will encompass the exclusion, decontamination, and support zones.

Temporary security fencing will remain in place until the remediation activities are concluded. The Health and Safety Coordinator will be responsible for maintaining a log of authorized project personnel allowed on-site.

All authorized Site visitors will be required to comply with the project health and safety requirements and training. Authorized visitors will be allowed to observe excavation and remediation activities from a designated observation area outside the exclusion zone. Authorized visitors allowed on-site within the exclusion zone must be accompanied by Site personnel at all times. All visitors allowed within the exclusion zone will be logged in/out by company name, which will be recorded in the visitor's log.

Site work is scheduled to be performed during normal City of Casper approved work hours (7:00 a.m. to 6:00 p.m. Monday through Friday).

3.6.3 Traffic and Pedestrian Controls

Traffic and pedestrian controls will provide a safe environment and efficient completion of work activities and minimize the impact on the normal traffic flow. The Site contractor will coordinate with the local businesses and the City of Casper to provide acceptable mitigation of the disturbance caused by the remediation project work.

A portion of Wolcott Street between East Midwest Avenue and East Collins Drive will be closed and blocked until completion of the remediation project. Traffic will be redirected and temporary traffic controls will be implemented as needed during all phases of the remediation project. All traffic control activities will conform to the applicable specifications of the "*Standard Specifications for Road and Bridge Construction,*" Wyoming Highway Department, latest edition. Traffic control devices will comply with the provisions for construction signing as set forth in the latest edition of the "*Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD)*."

Truck traffic to and from the Site delivering or removing materials will use extreme caution with respect to pedestrian traffic. Rigid barricades will be placed around the work zone with signs indicating the hazards within. A portion of this barricade will be removed during the day when work is in progress as necessary to complete project tasks. Standard construction barricades

will be utilized in the remedial area. On-site personnel will be alert at all times to potential unauthorized entry into the work area.

Access to Joshua's Storehouse and adjacent businesses will be kept operational at all times throughout the remedial project. The front door of Joshua's Storehouse will remain locked and blocked off during remediation and construction activities. Joshua's Storehouse plans to operate out of their bay doors on the south and west sides of the building and their walkway door on the west side of the building. Lai Thai and the Bank of the West will remain largely unaffected as Wolcott Street will remain open at their entrance/exit points.

All traffic control activities will be planned and managed by Keyhole Technologies, LLC (Keyhole). As required, Keyhole has completed and submitted a Traffic Control Plan for the remediation project to the Casper City Engineering Office. Keyhole is subcontracted to the construction subcontractor, Fuel Management Solutions (FMS). FMS will ensure that all traffic controls are installed prior to project start-up and the controls are maintained throughout the project duration.

A truck route has been established for hauling excavated material off-site and for hauling imported material on-site. The proposed haul route is shown on **Figure 2**.

3.6.4 Storm Water Controls

Storm water controls will be installed as necessary to prevent run-off from the Site during project activities. The following storm water run-off controls will be implemented:

- Sandbags (or equivalent) will be installed around the storm sewer located at Wolcott Street and Collins Drive on south side immediately adjacent to the Site;
- The remedial treatment area will be covered with tarps/plastic during a rain event;
- Temporary stockpiles will be covered with tarps/plastic during a rain event;
- Site work activities will cease for the duration of a rain event.

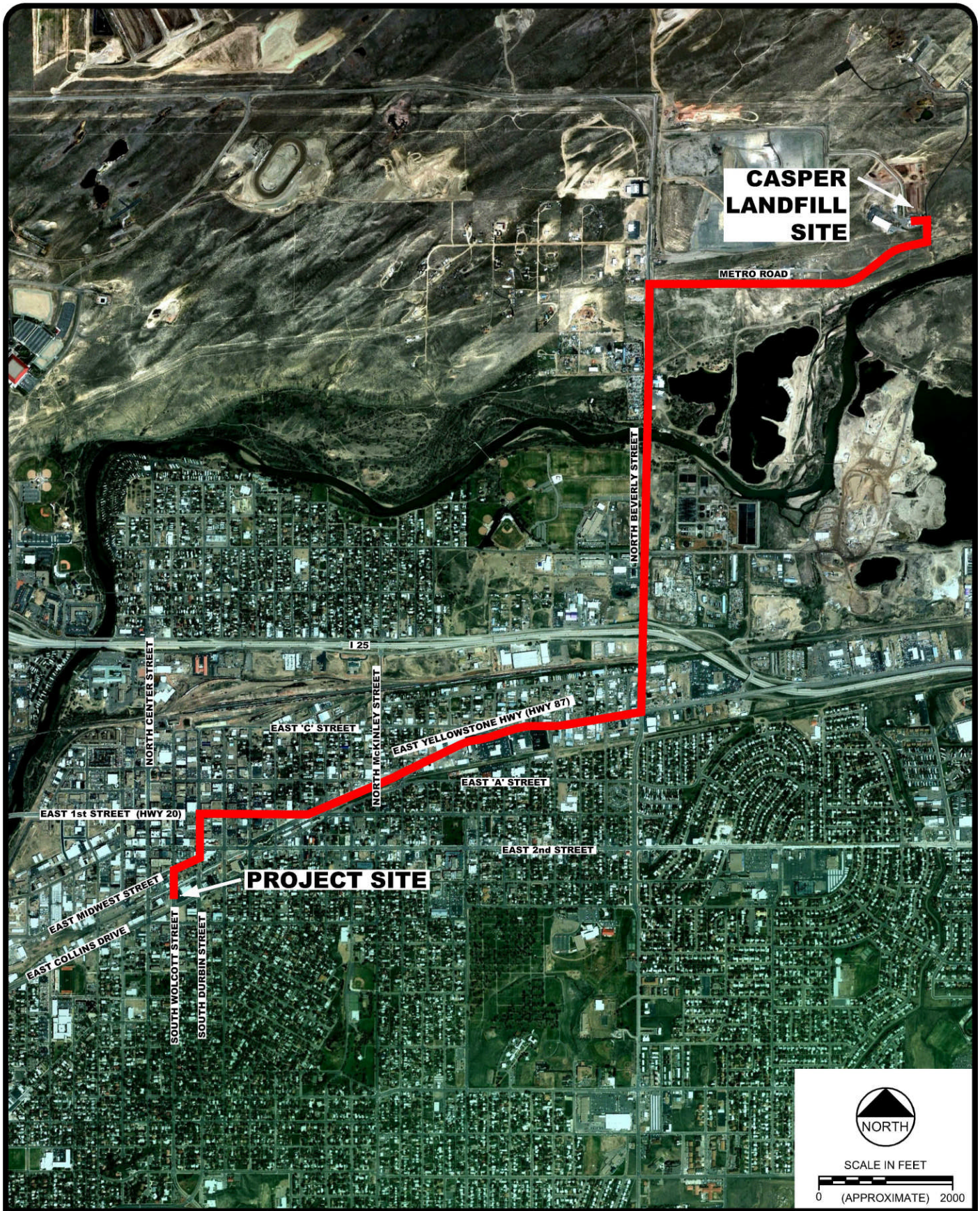
No storm water run-on from off-site is anticipated. However, any surface water will be diverted or otherwise prevented from entering excavated areas to the greatest extent practicable.

3.6.5 Exclusion, Staging, Support, and Loading Areas

The construction subcontractor will identify the location of the remedial excavation, treatment, and loading areas within the remedial area. Due to the large area over which excavation will occur, the boundaries of the excavation and treatment areas will change as the remedial action progresses.

The exclusion zone will incorporate the entire remedial area and include all areas of excavation, impacted waste/soil treatment, temporary staging (stockpile areas), and truck loading/unloading.

If needed, a decontamination area will be established immediately adjacent to the exclusion zone and used for decontamination of personnel, equipment, and vehicles exiting the exclusion zone. Decontamination procedures are described in Section 4.1.6 of this Work Plan.



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Wyoming DEQ - Wolcott Street Remediation Project - Former Lobell Refinery
Casper, Wyoming

TRUCK HAUL ROUTE

Project No.:	114-510538
Date:	June 2012
Drawn By:	MAT

FIGURE
2

Temporary facilities will be installed by the construction subcontractor within the designated work area but outside the exclusion zone. The support zone will be used for a construction office trailer and to temporarily store equipment and materials required for the excavation and construction activities.

4.0 PROJECT REQUISITES

4.1 Project Requirements

4.1.1 Health and Safety

A project specific health and safety plan (HASP) has been prepared for the remediation project. The HASP was prepared in accordance with Occupational Safety and Health Administration (OSHA) requirements and will be approved by a certified industrial hygienist.

The HASP for the Wolcott Street remediation project describes the health and safety procedures to be followed while conducting activities related to the remedial action. The HASP addresses worker health and safety, chemical and physical hazards, training requirements, and spill prevention and response procedures associated with the remediation activities.

The HASP will be available on-site at all times during the remedial activities. All field personnel, including subcontractors and authorized on-site visitors, will be required to review the plan and provide written acknowledgment of their review. In addition, a tailgate safety meeting will be held at the beginning of each workday to discuss relevant or task-specific safety issues.

4.1.2 Sampling and Analysis Plan

A Sampling and Analysis Plan (SAP) has been prepared for the Wolcott Street Acid Sludge Remediation project and is attached as **Appendix A** to this Work Plan. The SAP describes the sampling and analysis activities that will be performed during implementation of the remediation project, and was prepared in general accordance with VRP Fact Sheet #29, *Sampling and Analysis Plans*.

The purpose of the SAP is to control the remediation process for the on-site neutralization treatment and off-site disposal of treated waste material, and to verify that the remediation goals have been met.

Table 4.1-1 presents the screening and analytical methods that will be used for the remediation project.

Table 4.1-1 Environmental Media Sample Analytical Parameters		
Parameter	**Analytical Method**	**Screening/Action Level**
Waste/Soil/Backfill		
TPH-DRO	EPA Method 8015B	Treated waste – document for Casper Landfill disposal Excavation Clean-up Confirmation– Action Level 2,300 mg/kg Imported Clean Fill – Action Level 2,300 mg/kg Non-impacted Native Soil – Action Level 2,300 mg/kg
TPH-GRO	EPA Method 8015B	Imported Clean Fill – Action Level 28 mg/kg
TCLP RCRA 8 Metals	EPA Method 1311	Imported Clean Fill – Numerical limits for RCRA Toxicity Characteristics for each metal
pH	EPA Method 9045D	Excavation Clean-up Confirmation– Action Level pH > 5.0 & < 9.0 s.u.
pH	Hanna 99121 pH meter	Treated waste/soil– Target pH 6.0 – 8.0 s.u.
Paint Filter	EPA Method 9095	Treated Waste/Soil– Action Level Pass/Fail
Air		
LEL, oxygen, hydrogen sulfide, carbon monoxide, and sulfur dioxide	VRAE standard 4-gas + SO_2 monitor	Monitoring during remedial activities - OSHA Permissible Exposure Limit (PEL)

4.1.3 Quality Assurance/Quality Control Plan

A site-specific Quality Assurance/Quality Control Project Plan (QAPP) has been prepared for the remediation project and is attached as **Appendix B** of this Work Plan. The QAPP documents the planning, implementation, and assessment procedures for the remedial work and defines the quality assurance and quality control procedures that will be used to ensure quality data are collected.

Essential elements presented in the QAPP include project management, objectives, functional activities, and specific quality assurance (QA) and quality control (QC) activities associated with the Wolcott Street site remediation project.

The QAPP also describes the specific protocols that will be followed for sampling, sample handling and storage, chain of custody, and laboratory analysis. Data generation and acquisition, assessment and oversight, and data validation and usability are also addressed.

Under project management, project objectives are defined and the project organization, schedule, description, and definition of data quality objectives described. This includes a description of the problem and the decisions that will be made or outcome achieved for the project.

All QA/QC procedures are in accordance with applicable professional technical standards, Wyoming DEQ solid and hazardous waste division regulations and guidelines, and specific project goals and requirements.

4.1.4 Emergency Response Contingency Plan

An emergency response contingency plan has been prepared that defines the emergency procedures and protocol to be followed in the event of an emergency that presents immediate and dangerous threat to human health or life. This plan was developed with input from Source Gas, Century Link, City of Casper, and local emergency responder agencies. The plan addresses circumstances that may be highly unlikely but potentially catastrophic and includes fire, gas line failure, worker injuries, and the discovery of unforeseen chemicals.

The emergency response contingency plan addresses the following topics:

- Instructions on what to do in the event of a fire, explosion, injury, or discovery of unforeseen chemicals;
- The arrangements agreed to by local police and fire departments, hospitals, and state and local emergency response teams to provide emergency services;
- An emergency response coordinator who is responsible for assessing emergency situations and making decisions to respond;
- The names and phone numbers of all persons qualified to act as emergency coordinator;
- All emergency equipment at the Site;
- An evacuation plan.

At least one employee will be designated to be present or on-call at all times to act as an emergency response coordinator during all phases of the project.

All field personnel, including subcontractors, will be required to review the plan and provide written acknowledgment of their review. The Emergency Response Contingency Plan will be available on-site at all times during the remediation activities. In addition, a brief meeting will be held each morning with Joshua's Storehouse to keep them apprised of the daily and upcoming project activities.

4.1.5 Monitoring and Control

4.1.5.1 Fugitive Dust

Sources of airborne particulates during the remedial action include excavation activities, stockpiling, loading activities, and the exposed subgrade during excavation. Potential dust receptors could include on-site workers, nearby businesses, pedestrians near the Site, and vehicle drivers passing the Site.

Dust mitigation measures will be implemented as necessary during the remediation activities. Mitigation measures may include:

1. A water mist applied to dust-generating sources as necessary to minimize fugitive dust emissions.

2. Plastic sheets used to cover stockpiled soil or other exposed materials.

3. Cessation of soil disturbing activities during very high wind conditions when dust suppression measures are inadequate.

If needed, water for dust mitigation will be supplied by a city fire hydrant or a hose bib located on the north side of Joshua's Storehouse.

4.1.5.2 Noise

Activities such as heavy vehicle and equipment operation, sawcutting, and excavation equipment operation will contribute to elevated noise levels during construction. Receptors that could be affected by increased noise levels include on-site workers, nearby businesses, pedestrians near the Site, and vehicle drivers passing the Site. All equipment will be maintained in proper condition with exhaust controls to minimize noise levels. Normal working hours will be 7:00 a.m. to 6:00 p.m., Monday through Friday.

In accordance with Wyoming DEQ's Voluntary Remediation Program Green and Sustainable Remediation (GSR) Policy, vehicles and construction equipment used at the site will be properly maintained and heavy equipment will be shut off when not in use for more than five minutes.

4.1.6 Decontamination Procedures

If needed, the decontamination area will be lined with a 20-mil plastic liner and bermed with sandbags or soil and used for decontamination of personnel, equipment, and vehicles exiting the exclusion zone.

Decontamination will first involve a brush down of equipment/vehicles in the work area to remove visible accumulations of materials from the body and tires. Limited quantities of water may be used to remove residual visible contamination following dry brushing; however, water use will be minimized. If washing is necessary, equipment will be washed within the exclusion zone and the wash water mixed with the last load of excavated soil prior to off-site transportation to the Casper Landfill. In all instances, Site personnel will work to minimize the migration of mud and water to the street. Visible accumulations of soil, dust, or debris that are attributable to construction activities found on streets, rights-of-way, and access routes will be cleaned at a minimum of once per day.

4.1.7 Waste Management

Remedial excavation and treatment activities at the Site are expected to generate minimal non-hazardous waste. Any waste generated during project activities will be managed in accordance with regulatory requirements. The following waste streams are anticipated:

- Oversized debris, rock, concrete, asphalt, and miscellaneous debris;
- Used PPE;
- Sanitary waste;
- Miscellaneous trash and garbage.

All garbage and non-flammable waste materials will be contained in a self-contained portable dumpster or trash cage. Trash and debris will be picked up daily and deposited in an appropriate container. As needed and upon completion of project operations, accumulated trash will be cleaned up and removed from the Site and transported to a state approved waste disposal site. All dumpsters and trash containers will be removed from the Site at project closure.

In the event unforeseen chemicals or waste materials are discovered during remedial activities, the nature of the waste material will be assessed by on-site personnel to determine how the chemicals or waste can be managed in a safe and effective manner. At a minimum, the possible explosive conditions, toxic atmospheres, and physical hazards will be considered. As necessary, Wyoming DEQ will be consulted to ensure the unforeseen waste is managed appropriately.

4.1.7.1 Sanitary Facilities

A temporary sanitation facility will be installed at the Site as necessary for use by the on-site personnel. The sanitation facility will be located within the work area in the support zone. The portable chemical toilets provided for the use of workers during the remediation project will be pumped as required and the waste disposed of by a commercial operator.

4.1.8 Construction Specifications

All construction activities will be performed in accordance with the City of Casper Standard Specifications for Public Works, dated January 2006.

Construction activities on this project include:

- Traffic control and street closure during remediation activities;
- The construction of roadway embankment after completion of the remediation activities;
- Preparation of subgrade for placement of base course;
- Placement of 6 inches of base course materials on roadway;

- Replacement of any curb, gutter, or sidewalk removed or damaged during remediation activities.

City of Casper Standard Specifications for Public Works relevant to the work anticipated for the Wolcott Street remediation project are incorporated as **Appendix C** of this Work Plan.

5.0 REMEDIATION ACTIVITIES

The implementation of the remedial activities, from pre-construction to treatment and removal of impacted waste/soil, disposal, site restoration, and Site cleanup, is described.

The remedial area is defined by the width of Wolcott Street extending from the intersection of Wolcott Street and East Collins Drive northward approximately 170 feet to near the Rails to Trails crossing. **Figure 3** depicts the layout of the remedial area.

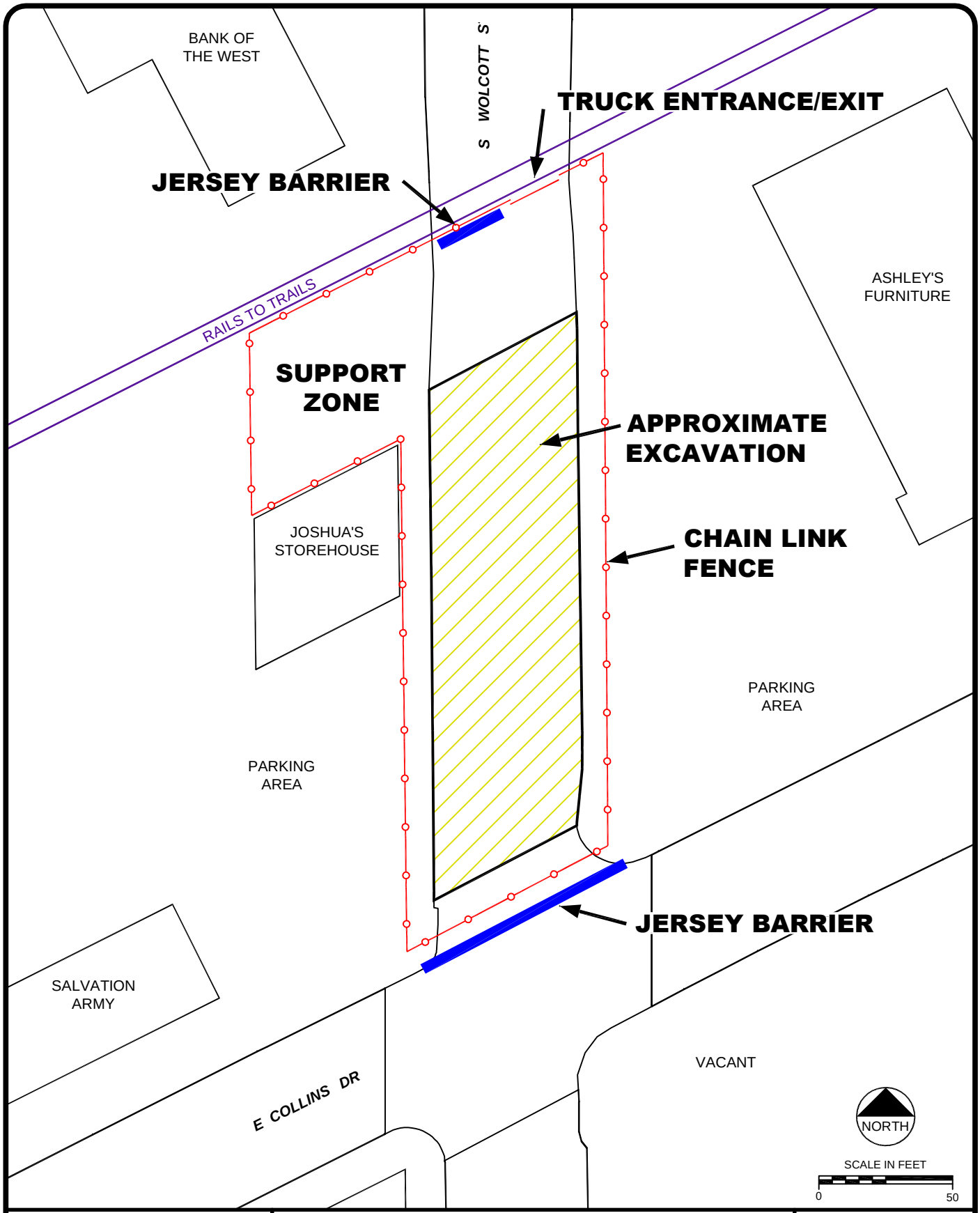
The Site remedial activities will involve removal of the existing street surface to expose the waste/soil, excavation and segregation of waste/soil showing visible petroleum hydrocarbon impacts and low pH values, on-site pH treatment by neutralization of the waste/soil using cement kiln dust (CKD), and transport of the treated material to the Casper Landfill for disposal as petroleum contaminated soils (PCS).

5.1 Pavement Removal

Street pavement will be removed in the remedial area to expose the waste/soil for remediation. Wolcott Street was originally paved with approximately 6 inches of concrete, which was subsequently overlain with paving fabric and several layers of asphalt. The existing thickness of the asphalt pavement in the remedial area is estimated to be 12 inches.

Prior to pavement removal, the street will be scraped with a skid loader or similar bladed equipment to remove the visible active tar-like seep material from the road surface and stockpiled on a plastic liner for temporary storage. Seep material observed to be penetrating the pavement layers will also be removed during the pavement excavation activities and placed in the same temporary stockpile. The seep material will later be processed in the treatment unit for pH neutralization during remediation activities.

The construction subcontractor, Fuel Management Solutions, Inc., will remove approximately 9,400 square feet of asphalt/concrete paving from the remedial area and, if necessary, approximately 245 square feet of sidewalk located just south of Joshua's Storehouse. The excavated paving and sidewalk material will be transported to an approved recycling facility. Sawcuts will be used at the boundaries of the pavement and sidewalk sections to be removed to facilitate a finished joint of old and new material during site restoration and street paving by the City of Casper. An excavator, loader, and/or other required equipment will be used as needed to break up and remove the pavement.



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Client: Wyoming DEQ

Wyoming DEQ - Wolcott Street Remediation Project - Former Lobell Refinery
Casper, Wyoming

LAYOUT OF REMEDIAL AREA

Project No.:	114-510538
Date:	June 2012
Drawn By:	MAT

FIGURE
3

5.2 Remediation Implementation

5.2.1 Excavation and Segregation

After the surface pavement is removed from the remedial area, the exposed waste/soil will be visually examined and field screened for pH using a direct reading soil pH probe in order to better define the distribution of the waste/soil. Information from this preliminary assessment will be used to identify areas of impacted waste/soil requiring treatment and areas of non-impacted native soil to be segregated. This procedure will be repeated with each layer exposed during the excavation process.

Excavation will begin along the southern edge of the remedial area with a working face roughly parallel to East Collins Drive. Areas determined to contain impacted waste/soil will be excavated in stages and transferred to the treatment area for neutralization and ultimate disposal to the Casper Landfill. Non-impacted native soil will be stockpiled within areas already excavated and utilized as needed for sidewall stability and excavation backfill.

The depth of excavation will be determined by visual evidence of the presence of waste but is not expected to exceed 6 feet. The construction subcontractor will remove waste/soil using a variety of mechanized equipment and hand tools. The excavation process will progress northward until the entire remedial area has been excavated.

The potential for damage to structures and utilities will limit the extent of excavation. Excavation activities will not proceed closer than three feet of the Source Gas main pipeline or the Century Link communications duct bank until a representative of the utility owner is present to authorize and direct further excavation. However, if the Project Manager or construction subcontractor deems further excavation at the utility line presents a safety risk due to potential utility damage, the activity will not be performed until the concerns have been addressed. No delays have been accounted for in this scope of work due to potential maintenance work by the utility owner. Wyoming DEQ will be notified of the occurrence of project delays due to unanticipated utility maintenance work.

During excavation activities near the foundation of Joshua's Storehouse, the sides of the excavation will be sloped to an angle not steeper than one horizontal to one vertical, or 45 degrees measured from the horizontal.

Joshua's Storehouse sewer line may be damaged if it is necessary to excavate any portion of the sidewalk located between Joshua's Storehouse and Collins Drive. Wyoming DEQ and Joshua's Storehouse will be consulted prior to excavation of the sidewalk.

Excavation sidewalls will be continually evaluated by the Field Team Supervisor and the construction subcontractor for stability. There is a potential that the sidewalls may need to be benched or sloped to prevent sidewall collapse and potentially compromise the structural stability of adjacent structures.

Structures that could be potentially compromised include utilities, Joshua's Storehouse foundation, streets, sidewalks, and curb and gutter. Benching or sloping of the sidewalls may limit the horizontal extent of the excavation. The Field Team Supervisor or Project Manager will promptly advise the Wyoming DEQ if sidewall stability is preventing or limiting the complete

removal of the waste/soil. The Project Manager and construction subcontractor will be prepared to present alternative methods or procedures, if any, that can be implemented to allow complete or more complete removal of the waste/soil from the excavation.

The treatment area, which is located within the remedial area, will be the last area to be excavated. This area will be excavated and segregated in the same manner described above and treated in a final relocated treatment area. After treatment is complete, the soils underlying the final treatment area will be excavated to a depth of six inches and transported to the Casper Landfill for disposal. This action should ensure any residual waste material that may have mixed into the underlying soil beneath the final treatment area is excavated and removed from the Site.

5.2.2 Confirmation Sampling

Confirmation sampling of the remedial excavation will be performed as excavation progresses in accordance with Wyoming DEQ Voluntary Remediation Program (VRP) Fact Sheet #10, Soil Confirmation Sampling Guidelines. Approximately eight floor and eight sidewall samples are anticipated to be collected for confirmation sampling. The sample locations will be evenly distributed in the excavation to ensure that the remedial objectives are met. These samples will be submitted to Pace Analytical Services and analyzed for total petroleum hydrocarbon diesel range organics, and pH in accordance with the SAP and QAPP.

Confirmation sampling of the remedial excavation will be conducted upon Wyoming DEQ's decision to conclude waste excavation in each portion of the remedial area.

5.2.3 Waste/Soil On-Site Treatment

Waste/soil will be excavated in stages and placed in the designated treatment area located in the northern portion of the remedial area. The waste/soil will be placed in a linear orientation approximately eight inches deep, eight feet wide, and over the working length of the treatment area, which is expected to vary during the remedial process depending on field conditions.

The neutralizing agent, cement kiln dust (CKD), will be placed on top of the eight inch lift of waste/soil in the treatment area at the rate of five percent by volume or less. The volume of CKD to be applied for each treatment will be measured using the known volume of the bucket on the loader or skid steer. CKD will be applied to the waste/soil using an agricultural drop spreader or equivalent type of solids spreading equipment equipped with a variable setting for the application rate. The drop spreader will be towed over the waste/soil layer using the skid steer or equivalent equipment.

An additional lift (approximately eight inches) of waste/soil will be placed on top of the layer of CKD. The two lifts of waste material and CKD will then be blended using the RM-500 soil reclaimer. Once blended, field pH screening of the treated material will be performed to evaluate if the material has been neutralized to the target pH range. If needed, additional treatment will be performed by supplemental addition of neutralizing agent or waste/soil followed by blending and subsequent field pH screening. After the target pH range of 6.0 – 8.0 s.u. has been achieved, the treated material will be loaded and transported for disposal at the Casper Landfill.

To meet the acceptance criteria for disposal at the Casper Landfill as PCS, the pH range of the treated waste must be greater than 5.0 s.u and less than 9.0 s.u. The Casper Landfill has agreed to accept documentation from the pilot test conducted in April 2012 that demonstrated

the pH of the waste/soil after treatment with CKD is greater than 5.0 s.u and less than 9.0 s.u. Further, the Casper Landfill deemed documentation of the following laboratory analytical results from the pilot test as sufficient evidence that the treated waste/soil meets their disposal requirements:

- TPH DRO: Detections ranged from 15,000 to 24,700 mg/kg
- TPH GRO: Not analyzed because previous studies indicate only heavier hydrocarbons are present in the waste
- TCLP RCRA Metals: Only barium was detected (0.29 to 0.38 mg/L)

Upon submittal of the above documentation, the Casper Landfill will require no further analyses for disposal of the treated waste/soil. However, verification sampling and laboratory analyses will be performed to document for the record that the treated waste/soil meets the requirements for Casper Landfill disposal.

In order to account for potential of pH rebound or over/under pH correction, the conservative treatment goal for waste/soil neutralization is between pH 6.0 and 8.0 s.u.

Laboratory verification sampling and analyses will be performed for the initial treatment batch. Waste/soil samples will be submitted to Pace Analytical Services and analyzed for total petroleum hydrocarbons diesel range organics and the paint filter test in accordance with the SAP and QAPP for documentation that the treated waste/soil meets Casper Landfill requirements. The verification sampling and analyses process will be repeated at approximately every 250 cubic yards of treated material. All other treated waste/soil will be hauled directly to the landfill after the field pH readings indicate the pH of the treated material is between 6.0 and 8.0 s.u.

5.2.4 Transportation and Disposal of Neutralized Waste/Soil

Haul trucks will be loaded at the northeast corner of the Site. After loading, the truck driver will perform a visual inspection for any material that may be located in a position where it could fall off the truck during transport. The truck will then proceed north along Wolcott Street and follow the approved designated truck haul route to the Casper Landfill (Figure 2).

All treated waste/soil will be disposed of at the Casper Landfill. Truck drivers will collect a copy of the load ticket from the landfill for each load. This ticket will be delivered to the Field Team/Remediation Supervisor upon return to the Site. The Field Team/Remediation Supervisor will submit all the load tickets to the Project Manager at the end of each day.

6.0 SITE RESTORATION

Site restoration activities will begin after all impacted waste/soil has been removed from the excavation, all confirmation and verification samples have been analyzed, and Wyoming DEQ has stated that no additional remedial activities are to be conducted. All site restoration activities will be completed in accordance with the 2006 City of Casper Standard Specifications for Public Works Construction and Infrastructure Improvements (herein after “City Specifications”).

6.1 Backfilling

Verification sampling and laboratory analysis will be conducted for soil to be used for excavation backfill. Areas identified as non-impacted native soil will be excavated from the remedial area and stockpiled in a designated area within the excavation and returned to the excavation for use as fill during Site restoration. If necessary, imported fill material documented as clean will be used as fill material for Site restoration.

Backfilling consists of the return of non-impacted native segregated soil stockpiled during waste/soil excavation, the placement of imported borrow material to replace the volume of waste/soil transported off-site for disposal, and the placement of road base to support asphaltic paving by the City of Casper. Backfilling the excavation will not commence until the results of the confirmation and verification sampling have been received unless backfilling is required to maintain excavation stability or to reduce the stockpile size of the segregated non-impacted native soil. Generally, the segregated non-impacted native soil will be placed in the base of the excavation followed by the imported borrow material. Additionally, imported borrow material will be used to establish excavation grades for the subsequent placement of road base material.

Imported borrow material and on-site materials conforming to low volume change materials as outlined below and approved by City of Casper will be utilized:

Gradation	**Percent Finer By Weight (ASTM C 136)**
3”	100
No. 4 Sieve	50-100
No. 200 Sieve	5-25
Liquid Limit	30 (max)
Plasticity Index	15 (max)

Records of the imported soil gradation and Atterberg limits will be reviewed to determine suitability of material prior to use. If sufficient records are not available for the imported material, additional testing (soil gradation and Atterberg limits) will be conducted to characterize the material.

The backfill materials will be moisture conditioned to within plus or minus two percent of optimum and will be compacted to a minimum of 95 percent of the maximum dry density as determined by ASTM D-698. Sufficient proctor tests (ASTM D-698) will be performed to characterize the range of imported and on-site backfill materials. The backfill materials will be placed in uniform lifts not to exceed six inches of compacted thickness and eight inches loose thickness as outlined in the City Specifications, Section 201.06 – Imported Borrow Excavation.

The excavation will be backfilled to a depth of six inches below final grade or as directed by the City of Casper. A six inch layer of crushed gravel base course will be placed on the compacted backfill material as specified in City Specifications Section 402 – Pavement Base Course. Prior to use of base course, material submittals from the supplier will be reviewed to ensure conformance with City Specifications Section 402 – Pavement Base Course.

One density and moisture test will be performed for every 5,000 tons or portion thereof of base course and backfill material placed. In addition, a gradation test and Atterberg limits test will be conducted for every 5,000 tons or portion thereof of base course material.

Sidewalks and curb and gutter will be constructed as specified in City Specifications Section 302 – Concrete Curb, Curb and Gutter, Curbwalk, Valley Gutters, Sidewalk, and Driveways.

6.2 Final Site Cleanup and Closure

At the conclusion of all remediation and construction activities, all security fencing and barriers will be removed. All temporary facilities and construction equipment will be demobilized from the Site. The construction subcontractor will coordinate with the City of Casper to transfer traffic control responsibilities to the City of Casper. All sidewalks and other adjacent areas that have dust or debris that can be associated with construction activities will be swept clean. Any remaining debris or other waste generated during the remediation work will be removed and properly disposed.

7.0 REPORTING

Within 60 days following project completion, a final remediation report will be submitted to Wyoming DEQ to document the remedial actions completed at the Site. The final remediation report will describe the remedial activities performed at the Site and include validated sample results, site photographs, field notes, analytical reports, and documented evidence of treated waste disposal at the Casper Landfill.

Appendix A

Sampling and Analysis Plan (SAP)

TETRA TECH

Sampling and Analysis Plan

Wolcott Street Acid Sludge Remediation Project

Former Lobell Refinery Orphan Site 57.004 Casper, Wyoming

Prepared for:

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July 27, 2012

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TABLE OF CONTENTS

1.0 INTRODUCTION

This Sampling and Analysis Plan (SAP) describes the sampling and analysis activities to be performed during implementation of the Wolcott Street Acid Sludge Remediation project located at the former Lobell Refinery Orphan Site 57.004 (Site) in Casper, Wyoming.

The Site, which is part of the former Lobell Refinery, is located in downtown Casper. The remedial area extends approximately 55 feet east across South Wolcott Street and approximately 170 feet north from East Collins Drive towards the Rails to Trails pathway**.**

The Site history and previous environmental investigations conducted for the former Lobell Refinery, which includes the Wolcott Street project area, are summarized in the Remediation Work Plan, Section 2.1, Site Background.

The purpose of the SAP is to control the remediation process for the on-site neutralization treatment and off-site disposal of the Wolcott Street treated acidic hydrocarbon waste and impacted soil (waste/soil) to the Casper Landfill, and to verify that the remediation goals have been met to the extent determined by Wyoming DEQ during the remedial action.

This SAP is a planning document only and is based on the scope of work previously identified by Wyoming DEQ. In the event the scope of work is revised, the SAP may be revised as necessary during remediation activities to meet the remediation requirements of Wyoming DEQ.

1.2 Existing Use and Planned Use

The Site is currently a road maintained by the City of Casper with sidewalks and adjacent commercial properties on each side of Wolcott Street. After remedial activities are completed, it is expected that the Site will continue to be used as a city maintained roadway and commercial use will continue at the adjacent properties.

Several site assessments and limited environmental site investigations have been performed since 1995 to characterize the contamination in the area of the former Lobell Refinery, which incorporates the boundaries of the Wolcott Street “seep” area addressed in this SAP. The previous site assessments and investigations are summarized in the Remediation Work Plan, Section 2.0, Site Conditions.

1.3 Purpose of the Remediation Project

The Wolcott Street remedial area has experienced acidic petroleum surface seeps from buried waste migrating upward to portions of Wolcott Street and the bordering sidewalk areas for several years. The source of the seep material appears to be from the former Lobell Refinery storage tanks or from a reported oil pit subsequently filled with soil circa 1911. The seeps are comprised of a tar-like material and lesser amounts of a clear low pH liquid. The waste material exhibits pH values of less than 2 standard units (s.u.). The low pH of the waste material seeping to the surface presents a potential exposure hazard to the public via dermal contact.

The purpose of the Wolcott Street Acid Sludge Remediation project is to remove the source of acidic hydrocarbon seeps migrating to the Wolcott Street surface in order to eliminate the

primary exposure pathway (dermal contact) and preclude other potential exposure pathways from becoming active.

1.4 Contaminants of Potential Concern

The contaminants of potential concern identified at the Site from previous investigations are total petroleum hydrocarbon diesel range organics (DRO) and low pH materials.

2.0 SCOPE OF WORK AND REMEDIAL ACTION

This Section generally describes the primary elements of the Wolcott Street remediation project. The Quality Assurance Project Plant (QAPP), which is attached to the Remediation Work Plan as **Appendix B,** presents detailed discussions of the data quality objectives (DQOs) and quality assurance/quality control for this project.

2.1 Remedial Project Description

The Remediation Work Plan provides details about the remedial project activities, which are summarized below in this SAP.

2.1.1 Remedial Area

The Site is located in downtown Casper, Wyoming, and surrounded by commercial businesses. The vertical and lateral extent of the impacted area (waste/soil) at Wolcott Street is not well defined. However, the remedial area as defined by Wyoming DEQ extends 55 feet east across South Wolcott Street and approximately 170 feet north from East Collins Drive towards the Rails to Trails crossing. The remediation Site layout is shown in Figure 3 of the Remediation Work Plan.

The Wyoming DEQ estimates the volume of subsurface waste and impacted soil that will require excavation, treatment by neutralization, and off-site disposal is approximately 1,000 cubic yards.

Subsurface utilities located within the remedial area include the Source Gas main, a Century Link communications duct bank (fiber optic line), and Joshua's Storehouse sewer line. Waste/soil excavation within close proximity to these subsurface utilities may be restricted by the utility owner. Excavation may also be limited by nearby building structures.

2.1.2 Site Preparation

The Site preparation activities are summarized below and described in the Remediation Work Plan in Section 3.6.1, Pre-Construction and Site Preparation, and Section 5.1, Pavement Removal. These activities are summarized below.

- Establish safety barriers to prevent public access to the Site.

- Remove approximately 9,400 square feet of asphalt/concrete road surface to expose the waste/soil.

- Upon pavement removal, conduct a preliminary visual examination of the remedial area to assess the distribution of waste/soil to be remediated and document the initial Site conditions with a photo survey.

- Conduct in situ pH readings at field-determined intervals across the exposed layer using a direct reading soil pH probe to delineate impacted and non-impacted areas.

- Remove and segregate non-impacted native soil in a temporary staging area for return to the excavation as backfill.

2.1.3 Remediation Implementation

The procedures for implementing the remedial action are described in the Remediation Work Plan in Section 5.2, Remediation Implementation. The remediation process is briefly summarized below:

- Excavate the impacted waste/soil material and transfer to the designated on-site treatment area.

- Place an 8-inch layer of waste/soil material over length of remedial treatment area; add a specified volume of the neutralization agent, cement kiln dust (CKD), across the waste layer; add a second 8-inch layer on top of neutralization agent; blend the layers using the RM-500 reclaimer.

- Conduct in situ pH readings at approximately 5 foot intervals across length of the treated waste/soil layer in the treatment area to assess the progress of the neutralization process.

- Conduct verification sampling to document the treated waste/soil meets the Casper Landfill disposal criteria. Verification sampling will be conducted initially for the first batch and for every 250 cubic yards thereafter.

- Transport treated waste/soil to the Casper Landfill for disposal as petroleum contaminated soil in accordance with landfill requirements.

2.1.4 Site Restoration

Site restoration activities are described in the in the Remediation Work Plan in Section 6.0, Site Restoration. A summary of the Site restoration activities are presented below:

- As excavation of impacted waste/soil is completed in a given area, confirmation samples will be collected from the excavation for laboratory analysis of pH and TPH-DRO, in accordance with Wyoming DEQ Voluntary Remediation Program (VRP) guidelines, VRP Fact Sheet #10, Soil Confirmation Sampling Guidelines.

- The depth and lateral extent of the area excavated will be measured using a tape measure or handheld GPS device.

- The excavation will be backfilled with stockpiled non-impacted native soils and imported clean fill material as needed, in accordance with City of Casper specifications.

- Excavation equipment will be decontaminated prior to removal off-site. Debris, trash, and barricades will be removed and adjacent areas will be swept or washed as needed.

2.2 Remedial Project Objectives

The objective of the remediation project is to eliminate the surface exposure pathway of the acidic hydrocarbon waste migrating to the Wolcott Street surface by excavation, on-site neutralization treatment, and off-site disposal of the treated waste/soil at the Casper Landfill as petroleum contaminated soil (PCS).

To meet the acceptance criteria for disposal at the Casper Landfill as PCS, the pH range of the treated waste/soil must be greater than 5.0 s.u. and less than 9.0 s.u. The Casper Landfill agreed to accept documentation from the pilot test conducted in April 2012 that demonstrated the pH of the waste/soil after treatment with cement kiln dust is greater than 5.0 s.u and less than 9.0 s.u. Further, the Casper Landfill deemed documentation of the following laboratory analytical results from the pilot test as sufficient evidence that the treated waste/soil meets their disposal requirements:

- TPH DRO: Detections ranged from 15,000 to 24,700 mg/kg
- TPH GRO: Not analyzed because previous studies indicate only heavier hydrocarbons are present in the waste
- TCLP RCRA Metals: Only barium was detected (0.29 to 0.38 mg/L)

With submittal of the above documentation, the Casper Landfill will require no further analyses for disposal of the treated waste/soil. However, verification sampling and laboratory analyses will be performed to document for the record that the treated waste/soil meets the requirements for Casper Landfill disposal.

In order to account for potential of pH rebound or over/under pH correction, the conservative treatment goal for waste/soil neutralization is between pH 6.0 and 8.0 s.u.

Table 2.2-1 provides a summary of the data to be collected for the remediation project.

Table 2.2-1 Summary of Project Data DATA COLLECTION TYPE, DATA PARAMETERS, AND DATA USES		
Source Materials	**Typical Data Parameters**	**Data Uses**
Subsurface Waste/Soil	In Situ pH, Visual Inspection	Identify impacted areas for treatment
Treated Waste/Soil	Total Petroleum Hydrocarbon Diesel Range Organics (TPH-DRO), In Situ pH	Laboratory verification to document treated waste/soil meets Casper Landfill requirements for disposal
Imported Clean Soil	TPH-DRO, TPH-Gasoline Range Organics, TCLP RCRA 8 Metals	If needed, laboratory verification that imported clean soil is suitable for use as excavation backfill
Non-impacted Native Soil	pH, TPH-DRO	Laboratory verification that non-impacted native soil is suitable for use as excavation backfill
Remediation Excavation	pH, TPH-DRO	Laboratory confirmation that extent of excavation is completed per Wyoming DEQ requirements
Vapors	Monitor for LEL, oxygen, hydrogen sulfide, carbon monoxide, and sulfur dioxide	Verify that no vapors are generated during the remedial action that may present a threat to human health

Table 2.2-2 below lists the analytical parameters and action levels for the media that will be screened and sampled for this project.

Table 2.2-2 Environmental Media Sample Analytical Parameters		
Parameter	**Analytical Method**	**Screening/Action Level**
Waste/Soil/Backfill		
TPH-DRO	EPA Method 8015B	Treated waste – document for Casper Landfill disposal Excavation Clean-up Confirmation ≤ 2,300 mg/kg Imported Clean Fill ≤ 2,300 mg/kg Non-impacted Native Soil ≤ 2,300 mg/kg
TPH-GRO	EPA Method 8015B	Imported Clean Fill – 28 mg/kg
TCLP RCRA 8 Metals	EPA Method 1311	Imported Clean Fill – Numerical limits for RCRA Toxicity Characteristics for each metal
pH	EPA Method 9045D	Excavation Clean-up Confirmation – pH > 5.0 s.u. & < 9.0 s.u.
pH	Hanna 99121 pH meter	Treated waste/soil - Target pH 6.0 – 8.0 s.u.
Paint Filter	EPA Method 9095	Treated Waste - Pass/Fail

Table 2.2-2 Environmental Media Sample Analytical Parameters		
Parameter	**Analytical Method**	**Screening/Action Level**
Air		
LEL, oxygen, hydrogen sulfide, carbon monoxide, and sulfur dioxide	VRAE standard 4-gas + SO_2 monitor	Monitoring during remedial activities - OSHA Permissible Exposure Limit (PEL)

3.0 SAMPLING AND ANALYSIS PROCEDURES

This Section summarizes the sampling and analysis procedures that will be used during the remediation project. It describes the in situ waste/soil pH measurements and sampling and analysis that will be performed to:

(1) delineate impacted waste/soil areas for excavation/treatment;

(2) collect samples for laboratory verification to document treated waste/soil meets landfill disposal requirements;

(3) collect samples for laboratory verification that imported clean soil and non-impacted native soil is suitable for use as excavation backfill;

(4) collect samples for laboratory confirmation of excavation cleanup per Wyoming DEQ requirements.

Analytical methods for all samples collected in accordance with this SAP are discussed in detail in Section 4.5, Analytical Methods and Requirements.

Field team members will perform the following activities before and during field activities, as applicable:

- Review and understand applicable governing documents;
- Record appropriate levels of documentation regarding activities conducted;
- Ensure coordination between key staff;
- Ensure coordination with the analytical laboratory;
- Obtain required sample containers and other supplies;
- Obtain, check, and calibrate field sampling equipment;
- Obtain and maintain personal protective equipment (PPE).

The Site-specific Health and Safety Plan (HASP) should be consulted to determine health and safety protocols for performing Site work for the remediation project. Standard operating procedures (SOPs) are provided as attachments to the QAPP.

3.1 In Situ pH Measurement

After removal of the surface asphalt/concrete paving in the remedial area, the exposed material will be visually examined and field screened with a pH meter to assess the distribution of waste/soil to be remediated. The in situ pH measurements will be conducted at field determined intervals across the exposed layer using a direct reading soil pH probe to identify impacted waste/soil areas and non-impacted areas of native soil. Initially no fewer than 10 in situ pH measurements will be taken over the remedial area.

Waste/soil removed from the remedial area will be treated on-site with a controlled application of cement kiln dust (CKD) to neutralize the waste/soil material for landfill disposal. After the excavated waste is blended with CKD in the treatment area, in situ pH measurements will be conducted at approximately 5-foot intervals across the treatment bed to determine if the treated waste has been neutralized to the target pH range of pH 6.0 to 8.0 s.u. If necessary, additional CKD or additional waste/soil will be added to the treatment area as necessary to reach the neutralization goal.

In situ pH measurement procedures are presented below. In situ pH measurement frequency may change as necessary to obtain representative data based on observations by the field crew.

3.1.1 In Situ Soil pH Measurement Equipment

Operational guidelines for determining the in situ pH in the waste/soil are described in standard operating procedure (SOP) No.1 as an attachment to the QAPP. Personnel performing the pH measurements are required to be familiar with the procedures detailed in the SOP.

A hand-held Hanna 99121 direct read portable soil pH meter or similar instrument will be used for in situ pH measurements during remedial excavation activities to identify the low pH areas in the remedial area to be excavated and during treatment activities to verify treatment goals have been met.

3.1.1.1 Soil pH Meter Calibration

The pH meter calibration will be performed using a two or three point method following the manufacturer's recommendations. Calibration buffers of pH 7 and pH 4 will be used. Calibration will be performed daily before use. A calibration check using a pH 7 buffer solution will be performed to verify instrument calibration. All calibration information will be recorded in a field logbook or on a field form.

3.1.1.2 In Situ pH Measurement Procedure

The in situ measurement procedure for waste/soil pH is presented below.

1. Perforate the waste/soil layer to a depth of about 1 to 3 inches with an appropriate soil drill or auger.

2. If the waste/soil is dry, moisten it with a small amount of distilled water.

3. Insert the pH probe pushing it slightly into the perforated waste/soil layer (approximately one inch depth) to ensure proper contact.

4. Observe the pH values and record the pH and temperature when stable.

5. Decontaminate the pH probe by rinsing with tap water. Decontaminate the soil auger between sample locations by removing visible material. The soil auger will be rinsed with tap water only if necessary.

3.2 Verification Sampling

Composited verification samples will be collected for the treated waste/soil and for the imported clean soil and non-impacted native soil to be used for excavation backfill.

3.2.1 Treated Waste/Soil Verification Sampling

Composited verification sampling and analyses will be performed for the first batch of treated waste/soil to verify the target pH has been achieved and the material meets the requirements for disposal at the Casper Landfill. Subsequent verification sampling and laboratory analyses of the treated waste/soil will be collected at the approximate rate of one per 250 cubic yards.

Samples of the treated waste/soil will be collected across the length of treatment area and composited for analysis as described below in Section 3.2.3, Composite Verification Sample Collection Procedures.

3.2.2 Backfill Verification Sampling

Verification sampling and laboratory analysis will be conducted for soil to be used for excavation backfill. Areas identified as non-impacted native soil will be excavated from the remedial area, stockpiled in a designated area within the excavation, and returned to the excavation for use as fill during Site restoration.

If necessary, imported fill material brought on-site may be subject to clean fill verification sampling and laboratory analysis if the soil is not documented as clean by the supplier. If the imported fill material is verified as clean, it will be used as fill material during Site restoration.

At least one composite sample will be collected for each 250 cubic yards of stockpiled imported or non-impacted native back fill material as required. A composite sample consisting of three aliquots will be collected, as described in Section 3.2.3, Composite Verification Sample Collection Procedures.

3.2.3 Composite Verification Sample Collection Procedures

Generally the following procedures will be followed for collection of composited samples but may change as necessary to obtain representative data based on field observations.

- Sampler will wear latex or nitrile gloves when collecting soil samples. New gloves will be worn for each sample collection.

- Only new or decontaminated sampling equipment will be used.

- Each sample area will be divided into three sections of approximately equal volume, with one section for each aliquot of the composite sample.

- One aliquot will be collected at each sample location. There will be three aliquots per composite sample.
- All aliquots will be approximately the same volume.
- The aliquot locations will be selected such that the resulting composite sample will characterize the sample area.
- Approximately one third of the final soil volume will be collected at each aliquot location. The final sample volume will be of sufficient quantity of soil to completely fill the specified laboratory sample container(s).
- The sample aliquots will be collected using a decontaminated stainless-steel spoon, plastic spoon, trowel, hand auger, or similar equipment.
- The three sample aliquots for a composite sample will be placed in a plastic bag, homogenized, and then transferred to the individual sample containers.
- TPH GRO sample containers for imported backfill soil (if needed) will be completely filled with minimal headspace.
- Only sample containers supplied by the analytical laboratory will be used.
- Sample containers will be properly labeled with a unique identification code prior to sampling.
- Sample containers as specified in Table 4.5-1, Analytical Methods and Requirements, will be filled.
- Sample containers will be promptly sealed after sample collection and placed in a zip-locked bag and in an iced cooler.
- Procedures presented in SOP No. 3, Sample Handling and Documentation, will be followed when decontaminating sample collection equipment.
- Sample locations will be carefully documented with hand held GPS equipment, measuring tape, visual estimates, and/or photo documentation as appropriate.

3.3 Post-Remedial Excavation Soil Confirmation Sampling

The objective of the post-remediation confirmation sampling is to document conditions of the lateral and vertical extent of the remedial excavation area and evaluate if the waste/soil has been effectively removed to the extent determined by Wyoming DEQ.

Confirmation waste/soil samples will be collected from the remedial area as excavation progresses in accordance with Wyoming DEQ Voluntary Remediation Program (VRP) Fact Sheet #10, Soil Confirmation Sampling Guidelines, and prior to placement of backfill material.

Confirmation samples will be submitted to Pace Analytical Services for pH and TPH-DRO laboratory analysis**.**

Discrete soil samples will be collected from the base and sidewalls of the open excavation after the visibly affected waste/soil has been removed. Confirmation samples will also be collected for laboratory analysis in the event Wyoming DEQ decides that visible waste/soil should be left in place in the excavation.

Approximately eight floor and eight sidewall samples are anticipated to be collected for confirmation sampling. The sample locations will be evenly distributed in the excavation to ensure that the remedial objectives are met.

If necessary, additional excavation may be performed based on the confirmation sampling results. Additional confirmation samples will be collected from the expanded remedial excavation area if additional excavation is required.

The confirmation sample analytical results will be used to document that the waste/soil in the remedial area was removed to the extent determined by Wyoming DEQ.

3.3.1 Confirmation Soil Sample Collection Procedure

Generally, the following procedures will be used for the confirmation soil sample collection.

- Sampler will wear latex or nitrile gloves during soil sample collection. New gloves will be worn for each sample.
- Only new or decontaminated sampling equipment will be used.
- One discrete (i.e., grab) soil sample will be collected at each sample location. Confirmation samples will not be composited.
- Any surface slough and smearing will be removed from the excavation sidewall or bottom before the sample is collected.
- A sufficient quantity of soil to completely fill the specified laboratory sample container(s) will be collected at each location using a decontaminated stainless-steel spoon, plastic spoon, trowel, hand auger, or similar equipment.
- If conditions are safe in the open excavation, the sampler will step into the excavation to collect the proper number of samples. If conditions are not safe, the excavator operator can remove a block of soil from the designated sampling location and bring the block of soil to an area that is safely and easily accessible by the sampler. To prevent cross-contamination, sample material will be collected from a portion of the soil that did not touch the edge of the bucket.
- Only sample containers supplied by the analytical laboratory will be used.
- Each sample will be transferred directly to the sample container.

- Sample containers will be properly labeled with a unique identification code prior to sampling.
- Sample containers as specified in Table 4.5-1, Analytical Methods and Requirements, will be filled.
- Sample containers will be promptly sealed after sample collection and placed in a zip-locked bag and in an iced cooler.
- Procedures presented in SOP No. 3, Sample Handling and Documentation, will be followed to decontaminate sample collection equipment.
- Sample locations will be carefully documented with hand held GPS equipment, measuring tape, visual estimates, and/or photo documentation as appropriate.

4.0 SAMPLE HANDLING AND DOCUMENTATION

4.1 Procedures for Sample Handling and Documentation

4.1.1 Sample Identification and Labeling

Samples collected during the remediation activities will be assigned unique sample identification numbers. These numbers are required for tracking the handling, analysis, and verification or validation status of all samples collected during monitoring. All sample labels will be filled out using waterproof ink. At a minimum, each label will contain the following information:

- Sample identification;
- Date and time of sample collection;
- Method of preservation used;
- Sampler's initials.

4.1.2 Sample Containers, Preservatives, and Holding Times

4.1.2.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, commercially-cleaned sample containers will be obtained from the analytical laboratory. The bottles will be labeled as described in the previous section.

4.1.2.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to ensure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping. Sample preservation requirements are presented in Table 4.5-1, Analytical Methods and Requirements.

4.1.2.3 Sample Holding Times and Analyses

Sample holding times are established to minimize chemical changes in a sample prior to analysis and/or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and/or extraction, based on the nature of the analyte of interest and chemical stability factors. Holding times applicable for analytes are listed in Table 4.5-1, Analytical Methods and Requirements.

For most samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

4.2 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described in the previous discussion, and placed on ice in an insulated cooler. The sample containers will be placed in re-closeable plastic storage bags. Samples will then be placed right side up in a cooler with ice for transport and delivery to the laboratory. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal.

4.2.1 Sample Documentation and Tracking

4.2.1.1 Field Notes

Documentation of observations and data acquired in the field provide information on sample acquisition, field conditions at the time of sampling, and a permanent record of field activities. Field observations and data collected during routine monitoring activities will be recorded in a field log. Field notebook and/or data sheet entries will, at a minimum, include the information listed below. Relevant SOPs should be consulted to supplement this list.

- Project name;
- Location of sample;
- Data and time of sample collection;
- Sample identification numbers;
- Description of sample (matrix sampled);

- Sample depth (if applicable);
- Sample methods, or reference to the appropriate SOP;
- Field observations (if applicable);
- Results of any field measurements; and
- Sampler's name.

Changes or deletions in the field book or on the data sheets should be recorded with a single strike mark, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without having to rely on the collector's memory.

All field logs will be signed on a daily basis by the person who has made the entries. Anyone making entries in another person's field log will sign and date those entries.

4.2.1.2 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Establishment of traceability of data is crucial for resolving future problems if analytical results are called into question and for minimizing the possibility of sample mix-up. Initial information concerning collection of the samples will be recorded in the field log book or on data sheets as described above. Information on the custody, transfer, handling and shipping of samples will be recorded on a Chain-of-Custody (COC) form provided by the laboratory.

The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. A COC form will be completed for each set of samples collected, and will contain the following information:

- Sampler's signature and affiliation
- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Any additional instructions to the laboratory.

The person responsible for shipping of the samples to the laboratory will sign the COC form, retain the third copy of the form, document the method of shipment, and send the original and the second copy of the form with the samples. Upon arrival at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project Manager. Copies of all COC documentation will be compiled and maintained in the central project file. The original COC forms will remain with the samples until the time of final disposition. The laboratory will send a copy of the original COC to Tetra Tech. This will then be incorporated into the central project file.

4.3 Equipment Decontamination

All equipment will be decontaminated following procedures specified in SOP #2. Sampling equipment must be decontaminated between sample collection points if equipment is not disposable. Field personnel must wear disposable latex or nitrile gloves while decontaminating equipment at the project site. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

In order to decontaminate durable sampling equipment such as shovels, trowels, soil augers, the sampling equipment should be visually inspected for contamination.

The general decontamination sequence for field equipment includes the following procedures:

- A stiff brush should be used to remove any visible material;
- Wash with Liquinox® or an equivalent degreasing detergent;
- Rinse with tap water and/or rinse with deionized/distilled water;
- Garden type sprayers may be utilized to contain wash and rinse solutions.

The soil auger used for in situ pH measurements will be decontaminated between sample locations by removing visible material. The soil auger will be rinsed with tap water only if necessary.

Decontaminated equipment will be protected from contamination if not used immediately. Wash water and rinseate solutions will be mixed with the load of treated waste being transported to the Casper Landfill for disposal.

All disposable items (e.g., paper towels, latex gloves) will be deposited into a garbage bag and disposed of in a proper manner.

Heavy equipment, tools, and vehicles used on-site will be decontaminated prior to leaving the work area. The equipment will first be brushed down to remove any visible accumulations. If necessary, limited quantities of water will be used to wash the equipment to remove residual accumulations. If visible contamination remains, then hot water pressure washing with a soap solution will be performed.

If needed, a decontamination area will be established immediately adjacent to the exclusion zone. The decontamination area will be lined with a 20-mil plastic liner and bermed with

sandbags or soil and used for decontamination of personnel, equipment, and vehicles exiting the exclusion zone. The wash water mixed with the last load of excavated soil prior to offsite transportation to the Casper Landfill.

In all instances, the contractor will work to minimize the migration of mud and water to the street. Visible accumulations of soil, dust, or debris that are attributable to construction activities found on streets, rights-of-way, and access routes will be cleaned at a minimum of once per day.

The site-specific Health and Safety Plan shall be followed during all decontamination procedures. Personnel will wear appropriate personal protection equipment during decontamination.

4.4 Quality Assurance/Quality Control and Data Evaluation

Quality assurance/quality control (QA/QC) for the project will consist of following the Data Quality Objectives (DQOs) developed for the project, collecting QA/QC samples, and completing a data evaluation on samples collected for the project. A Quality Assurance Project Plan (QAPP) was developed to define general DQOs and guide data acquisition and data evaluation activities. The QAPP may be found in Appendix B of the Remediation Work Plan.

Personnel involved with field activities, evaluation of data, and reporting will use the QAPP as a guide for QA/QC during the project. All reusable sampling equipment will be decontaminated prior to use at the Site and between sampling intervals and locations. Applicable Standard Operating Procedures are contained in the QAPP. The SOPs will be used as a guide to personnel completing field activities.

QA/QC samples that will be collected and analyzed during the remedial action include field duplicates and rinseates (if needed). The QAPP provides details on the collection frequency requirements for each QA/QC sample as well as other QA/QC requirements and procedures for this project.

4.5 Analytical Methods and Requirements

Field personnel will collect all soil and waste/soil samples in laboratory-provided containers and preserve the samples as required by the laboratory analytical method. Samples will be transferred under chain-of-custody procedures for analysis by Pace Analytical Services in coolers with double bagged ice for preservation.

Table 4.5-1 provides a list of parameters, the analytical method, reporting limits, sample containers, holding times, and preservation requirements for each parameter that will be analyzed by the laboratory during this investigation.

Table 4.5-1 Analytical Methods and Requirements					
Parameter	**Method**	**Reporting Limit**	**Sample Container**	**Holding Time**	**Preservation**
Total Petroleum Hydrocarbons-Gasoline Range Organics	EPA Method 8015B	10 mg/kg	4 oz Glass	14 Days	Cool to 4° C
Total Petroleum Hydrocarbons-Diesel Range Organics	EPA Method 8015B	10 mg/kg	9 oz Glass	14 Days Extraction; 40 Days Analysis	Cool to 4° C
TCLP RCRA 8 Metals	EPA Method 1311 Extraction/6010 Analysis/Hg 7470	must be 1/10th of regulatory limit	8 oz Glass	28 Days	None
Paint Filter Test	EPA Method 9095	1mL/hour	4 oz /Glass	NA	None
pH	SW9045C	0.01 s.u.	4 oz Glass	NA	None

4.6 Standard Operating Procedures

The QAPP in Appendix B of the Remediation Work Plan provides standard operating procedures (SOPs) for guidance during completion of the field activities. SOPs applicable for use on this project include SOP No.1 In Situ Measurements of Soil pH, SOP No. 2 Equipment Decontamination, and SOP No. 3 Sample Handling and Documentation.

4.7 Health and Safety Plan

A project specific health and safety plan (HASP) has been prepared for the Wolcott Street remediation project and will be available onsite at all times. The HASP was prepared in accordance with Occupational Safety and Health Administration (OSHA) requirements and has been approved by a certified industrial hygienist. All field personnel, including subcontractors, will be required to review the HASP and provide written acknowledgement of their review.

4.8 Deliverables

Copies of the Chain of Custody reports and laboratory reports will be submitted to Wyoming DEQ with the final report of the remediation project.

Appendix B

Quality Assurance Project Plan (QAPP)

TETRA TECH

Quality Assurance Project Plan

Wolcott Street Acid Sludge Remediation Project

Former Lobell Refinery Orphan Site 57.004 Casper, Wyoming

Prepared for:

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July 27, 2012

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1.0 INTRODUCTION

This Quality Assurance Project Plan (QAPP) was prepared to document the quality assurance (QA) and quality control (QC) measures that will be utilized during implementation of the Wolcott Street Acid Sludge Remediation project, and to ensure the precision and accuracy of data collected during the remedial effort. The QAPP presents data quality objectives, sampling methods, minimum data requirements for sampling, and data validation procedures that will be employed during the remediation project.

The QAPP is part of the Statement of Work prepared for the remediation at the Wolcott Street portion of the Former Lobell Refinery Orphan Site 57.004 (Site) in Casper, Wyoming. The remediation is being conducted under the Orphan Site Program and will therefore be managed by the Wyoming Department of Environmental Quality (Wyoming DEQ).

All QA/QC procedures presented herein are in accordance with applicable professional technical standards, Wyoming DEQ requirements and guidelines, and specific project goals and requirements as defined by the scope of work provided by Wyoming DEQ.

1.1 Project Organization

The key project team members and their responsibilities are described in **Table 1-1**.

Table 1.1-1 Key Project Team Members and Responsibilities

Role	Personnel	Responsibilities
Wyoming DEQ Project Manager	Cindi Martinez	-Oversight of and coordination with Tetra Tech -Review all project planning documents and plans -Ensure project compliance with State requirements and guidance -Interface with members of the public and stakeholders
Tetra Tech Project Manager (PM)	Scot Keith	-Project Manager -Primary point of contact for Wyoming DEQ -Leads project team -Evaluate project status reports -Take appropriate action to address and resolve issues and problems
Tetra Tech Project Director (PD)	Dorothy Hall	-Provide technical support for project activities -Support Project Manager as necessary -Alternate Emergency Coordinator if necessary
Tetra Tech QA/QC Officer	Dorothy Hall	-Provide senior peer review
Tetra Tech Field Team/Remediation Supervisor (FT/RS)	Joe Scott	-Direct remediation treatment activities -Oversee subcontractor performance -Provide cost tracking information to the PM for construction activities

Table 1.1-1 Key Project Team Members and Responsibilities		
Role	**Personnel**	**Responsibilities**
Tetra Tech Site Safety Coordinator (SSC)	Joe Scott	-Oversee site safety --Primary emergency response coordinator
Remediation Technician (RT)	Matt McCann	-Assist FT/RS in coordinating subcontractors activities and provide oversight of waste/soil excavation and treatment activities -Collect field measurements and verification and confirmation samples - Escort authorized Site visitors as requested -Back-up emergency response coordinator
Tetra Tech Corporate Health & Safety Program Manager	Yvonne Freix	-Consultation during unforeseen Site conditions and for complex health & safety issues -Review Site-specific Health and Safety Plan
Tetra Tech Engineering Support	Jason Stratton, PE	-Provide geotechnical and civil engineering consultation and oversight for engineering/ geotechnical work during all phases of the project
	Jared Jung, PE	-Develop the project construction specifications -Provide construction oversight during backfilling and project closure
Materials Testing and Construction Services	Mark Peloquin	-Direct construction materials testing and preparation as necessary during the site restoration and construction project phase
	Nate Becker	-Provide construction oversight and construction materials testing during the construction and restoration phase of the project
Fuel Management Solutions (FMS) Construction Project Manager	Brad Nelson	-Project Manager for FMS -Manage Keyhole Technologies (traffic control contractor) -Manage proposed changes during construction Activities -Ensure health & safety procedures are followed during construction activities -Back-up Emergency Response Coordinator
FMS Foreman	Chad Federer	-Full time on-site Foreman for FMS -Direct all FMS on-site construction activities -Work closely with FT/RS to ensure smooth and efficient operation of on-site activities -Back-up Emergency Response Coordinator

1.2 Project Objectives

The objective of the remediation project is to eliminate the surface exposure pathway of the acidic hydrocarbon waste migrating to the Wolcott Street surface. The remedy selected by the Wyoming DEQ to remediate the acidic hydrocarbon waste material and impacted soil (waste/soil) is excavation, on-site treatment by pH neutralization, and transportation for off-site disposal of the treated material to the Casper Landfill as petroleum contaminated soil (PCS).

1.3 Project Schedule

The on-site remediation activities are anticipated to commence on or about the week of July 30, 2012, based on input from Wyoming DEQ and the City of Casper. Because warmer temperatures are required for asphaltic concrete paving, the remedial activities will need to be completed and the excavation backfilled in preparation of paving by the City of Casper prior to the end of September.

1.4 Project Description

The goal of the remediation is to prevent the occurrence of seeps by removal and remediation of the presumed source of the acidic hydrocarbon waste and impacted soil (waste/soil) within the Wolcott Street remedial area defined by Wyoming DEQ. Achieving this goal will eliminate the primary exposure pathway (dermal contact) and preclude other potential exposure pathways from becoming active. The end result of the implemented remedial action will be the removal of the waste/soil within the defined portion of Wolcott Street and a compacted subsurface suitable for paving by the City of Casper.

Based on information collected to date, the acidic hydrocarbon waste exhibits a pH of less than 2.0 standard units (s.u.) as well as concentration of total petroleum hydrocarbon diesel range organics (TPH-DRO) above the Wyoming DEQ Voluntary Remediation Program (VRP) cleanup standards, as listed in VRP Fact Sheet 12, Soil Clean Levels. Available data suggests the hydrocarbon acidic waste occurs beneath Wolcott Street from near the intersection with East Collins Drive extending north approximately 170 feet and across the width of Wolcott Street (55 feet). Additionally there appears to be a portion of the waste that occurs beneath a section of sidewalk just south of Joshua's Storehouse.

The Site remedial activities will involve removal of the existing street surface, excavation and segregation of waste/soil showing visible petroleum hydrocarbon impacts and low pH values, on-site pH treatment by neutralization of the soil/waste using cement kiln dust (CKD), and transport of the treated material to the Casper Landfill for disposal as petroleum contaminated soils (PCS). The excavation will be subsequently backfilled to grade according to City of Casper Specifications. The City of Casper will be responsible for repaving Wolcott Street.

1.5 Data Quality Objectives

Data Quality Objectives (DQOs) for the remediation project were developed to ensure data quality and to define procedures for data collection. DQOs were developed following the recommendations in EPA guidance documents (EPA 1994 and 1998) and Wyoming DEQ Voluntary Remediation Program Fact Sheet #28, Data Quality Objectives (WDEQ 2007). The DQO process allows the level of data quality required to be determined for specific data collection activities and to estimate the costs associated with the activities.

1.5.1 Problem Statement

Wyoming DEQ has decided to remediate the waste/soil at the Wolcott Street Site. The remedy selected by Wyoming DEQ to remediate the waste/soil is excavation, on-site pH neutralization, and transportation for off-site disposal of the treated material to the Casper Landfill as petroleum contaminated soil (PCS).

Wolcott Street has experienced acidic petroleum surface seeps that have migrated upward from the subsurface to the street and bordering sidewalk areas for several years. The source of the seep material appears to be either from the former Lobell Refinery storage tanks or from a reported oil pit subsequently filled with soil. The seeps are comprised of a tar-like material and lesser amounts of a clear liquid. These materials have been found to exhibit pH values of less than 2.0 standard units (s.u.). The low pH of the seep material presents a public exposure hazard via dermal contact.

The Wolcott Street Acid Sludge Remediation Project is located in downtown Casper. The remedial area, as defined by Wyoming DEQ, extends approximately 55 feet east across South Wolcott Street and approximately 170 feet north from East Collins Drive towards the Rails to Trails crossing. The purpose of the remediation project is to remove and remediate the waste/soil that occurs beneath the Wolcott Street area.

The known contaminants of concern identified at the Site from previous investigations include low pH waste material and total petroleum hydrocarbon diesel range organics (TPH-DRO).

1.5.2 Decision Statement

The Site remedial activities will involve removal of the existing street surface, excavation of waste/soil with visible petroleum hydrocarbons and exhibiting low pH values, on-site treatment by pH neutralization of the waste/soil using cement kiln dust, and transport of treated waste to the Casper Landfill for disposal as petroleum contaminated soil (PCS).

The waste/soil will be treated on-site with a controlled application of cement kiln dust (CKD) to neutralize the waste material. The target pH range for on-site neutralization treatment of the waste/soil is pH 6.0 to 8.0 s.u. The acceptance criteria for disposal of the treated waste/soil at the Casper Landfill as petroleum contaminated soil (PCS) is a pH range greater than 5.0 s.u and less than 9.0 s.u.

The Casper Landfill has agreed to accept documentation from the pilot test conducted in April 2012 that demonstrated the pH of the waste/soil after treatment with CKD is greater than 5.0 s.u. and less than 9.0 s.u. Further, the Casper Landfill deemed documentation of the following laboratory analytical results from the pilot test as sufficient evidence that the treated waste/soil meets their disposal requirements:

- TPH DRO: Detections ranged from 15,000 to 24,700 mg/kg
- TPH GRO: Not analyzed because previous studies indicate only heavier hydrocarbons are present in the waste
- TCLP RCRA Metals: Only barium was detected (0.29 to 0.38 mg/L)

With submittal of the above documentation, the Casper Landfill will require no further analyses for disposal of the treated waste/soil. However, verification sampling and laboratory analyses will be performed to document for the record that the treated waste/soil meets the requirements for Casper Landfill disposal.

Visual inspection and in situ pH analysis will be conducted to delineate the distribution of waste/soil. Verification data will be used to support decisions about the extent of waste/soil in the remedial area that requires excavation and treatment and to identify areas of non-impacted native soil that may be used as excavation fill material during Site restoration. Verification sampling and analysis will be performed to ensure that non-impacted native soil and imported clean soil are suitable for as use as backfill material.

Post-remediation confirmation sampling and laboratory analyses from the excavation will be performed to confirm that the Wyoming DEQ remedial objectives have been met.

The data described above will be evaluated as it is gathered during the implementation of the Remediation Work Plan and used to make necessary decisions based on answers to the following decision statements:

- Does data collected from previous environmental investigations sufficiently delineate the lateral and vertical extent of the waste in the remedial area?
- Does the occurrence of waste/soil extend beyond the remedial area defined by Wyoming DEQ?
- Do visual inspections and in situ pH readings of the exposed waste/soil in the remedial area adequately identify the waste areas that require remediation?
- What is the lateral extent of the area impacted by the waste/soil?
- What depth of excavation is required within the currently defined remedial area?
- What is the impact if Wyoming DEQ determines waste/soil should be left in place in the remedial area?
- Does the data collected demonstrate the remediation process meets the requirements for disposal at the Casper Landfill?
- Are backfill materials (non-impacted native soil and imported clean soil) used to replace excavated waste/soil suitable for placement in the excavation?

1.5.3 Decision Inputs

Data required to address the decision statements will include the physical and chemical characteristics of waste/soil. Where enough data are available, data requirements may also include estimating contaminant waste volumes. Information and data available from historical record searches, previous investigations, and the remedial alternative selected by Wyoming DEQ were used to develop the QAPP with respect to Site cleanup.

Table 1.5-1 summarizes specific decision inputs for the remedial action.

Table 1.5-1 Summary of Project Data Data Collection Type, Data Parameters and Data Uses		
Source Materials	**Typical Data Parameters**	**Data Uses**
Subsurface Waste/Soil	In Situ pH, Visual Inspection	Identify impacted areas for treatment
Treated Waste/Soil	Total Petroleum Hydrocarbon Diesel Range Organics (TPH-DRO), In Situ pH	Laboratory verification to document treated waste/soil meets Casper Landfill requirements for disposal
Imported Clean Soil	TPH-DRO, TPH Gasoline Range Organics, TCLP RCRA 8 Metals	If needed, laboratory verification that imported clean soil is suitable for use as excavation backfill
Non-impacted Native Soil	pH, TPH-DRO	Laboratory verification that non-impacted native soil is suitable for use as excavation backfill
Remediation Excavation	pH, TPH-DRO	Laboratory confirmation that extent of excavation is completed per Wyoming DEQ requirements
Vapors	Monitor for LEL, oxygen, hydrogen sulfide, carbon monoxide, and sulfur dioxide	Verify that no vapors are generated during the remedial action that may present a threat to human health.

1.5.4 Remedial Boundary

The Site is located in downtown Casper, Wyoming, and surrounded by commercial businesses. The vertical and lateral extent of the impact area is not well defined. However, the presumed impacted area containing waste/soil to be remediated (remedial area), as defined by Wyoming DEQ, extends approximately 55 feet east across South Wolcott Street and approximately 170 feet north from East Collins Drive towards the Rails to Trails.

Figure 3 of the Remedial Work Plan shows the layout of the Site and the presumed excavation boundary. The estimated volume of waste/soil that will require excavation and treatment by neutralization is estimated by Wyoming DEQ to be approximately 1,000 cubic yards.

1.5.5 Decision Rule

Decision rules are specified below and describe actions based on quantitative screening data. Laboratory analytical data for the sampled media (clean soil and treated waste/soil) will be compared to screening/action levels described below. For contaminants detected above the screening/action levels in treated waste/soil, additional waste/soil neutralization or mitigation will be proposed. For contaminants detected below the screening/action levels in the treated waste/soil, removal from the Site and disposal at the Casper Landfill will be proposed.

The following decision rules will be applied:

- Pilot scale testing determined an application rate of 5% by volume of cement kiln dust (CKD) was needed to neutralize the waste/soil to a pH range of 6.0 to 8.0 s.u. This treatment application rate will be confirmed during full scale remedial operations.

- If the average pH of the treated waste/soil material is less than pH 6.0 s.u. after CKD application, additional neutralizing agent will be blended with the treated waste/soil to increase the pH of the treated waste.

- If the average pH of the treated waste/soil material is greater than pH 8.0 s.u. after CKD application, additional waste/soil or non-impacted native soil will be blended with treated waste/soil to decrease the pH of the treated waste.

- If the average pH of the treated waste/soil material ranges from pH 6.0 to 8.0 s.u., verification sampling and laboratory analyses for Total Petroleum Hydrocarbon Diesel Range Organics (TPH DRO) will be performed for the first batch of treated waste/soil to document that the treated waste/soil meets the requirements for disposal at the Casper Landfill. Subsequent verification sampling and laboratory analyses of the treated waste/soil will be performed at the approximate rate of one per 250 cubic yards of excavated waste.

- The excavation of waste/soil from the remedial area will be considered complete after confirmation sampling and laboratory analysis shows the pH of the soil from the excavation is greater than pH 5.0 s.u. or less than 9.0 s.u. and the concentration of TPH DRO does not exceed 2,300 mg/kg.

- If Wyoming DEQ determines waste/soil should be left in place in a portion of the remedial area during excavation, confirmation sampling and laboratory analysis will be performed to determine the concentration of TPH DRO.

- If laboratory analysis of the non-impacted native soil segregated from the remedial area during excavation shows a concentration of TPH DRO greater than 2,300 mg/kg, the soil will be transported to the Casper Landfill as petroleum contaminated soil and will not be used as excavation backfill material.

1.5.6 Tolerable Limits of Decision Errors

Decision errors are incorrect conclusions about a site caused by using data that are not representative of site conditions due to sampling or analytical error. Limits on decision error are typically established to control the effect of sampling and measurement errors on decisions regarding a site, thereby reducing the likelihood that an incorrect decision is made. The null hypothesis is that a site is contaminated. A false positive decision error is one that decides a site is clean when, in actuality, it is not clean. A false negative decision error is one that decides a site requires cleanup when, in actuality, it requires no cleanup. False positive and negative decision errors should be minimized as much as possible during this project.

The QAPP identifies specific field and laboratory methods and sampling strategies that reduce sampling error. The total error will be reduced by collecting an appropriate number of environmental samples deemed necessary that are intended to represent the range of concentrations present at the Site. The sampling program is designed to reduce sampling error by specifying an adequate number and distribution of samples to meet project objectives.

Inconsistencies in field screening and inspection standards may arise from human error or a change in field staff. The field staff will be required to review and follow the sampling protocols

detailed in the Sampling and Analysis Plan provided in Appendix A of the Remediation Work Plan before field work begins.

Human errors may also arise in the laboratory during sample handling, sample preparation, or sample analysis. Personnel in the laboratory will review and follow the standard operating procedures of quality assurance and of analytical methods established by the laboratory to minimize human errors.

Lack of homogeneity characteristic of soil samples may bias screening and analytical results. Soil samples may need to be reanalyzed to verify the results.

Table 1.5-2 below includes a list of media to screen and sample during this project and appropriate analytical methods.

Table 1.5-2 Environmental Media Sample Analytical Parameters

Parameter	Analytical Method	Screening/Action Level
Waste/Soil/Backfill		
TPH-DRO	EPA Method 8015B	Treated waste – document for Casper Landfill disposal Excavation Clean-up Confirmation ≤ 2,300 mg/kg Imported Clean Fill ≤ 2,300 mg/kg Non-impacted Native Soil ≤ 2,300 mg/kg
TPH-GRO	EPA Method 8015B	Imported Clean Fill – 28 mg/kg
TCLP RCRA 8 Metals	EPA Method 1311	Imported Clean Fill – Numerical limits for RCRA Toxicity Characteristics for each metal
pH	EPA Method 9045D	Excavation Clean-up Confirmation – pH > 5.0 s.u. & < 9.0 s.u.
pH	Hanna 99121 pH meter	Treated waste/soil - Target pH 6.0 – 8.0 s.u.
Paint Filter	EPA Method 9095	Treated Waste - Pass/Fail
Air		
LEL, oxygen, hydrogen sulfide, carbon monoxide, and sulfur dioxide	VRAE standard 4-gas + SO_2 monitor	Monitoring during remedial activities - OSHA Permissible Exposure Limit (PEL)

1.5.7 Sampling Design

A project-specific Sampling and Analysis Plan (SAP) has been prepared that describes the sampling and analysis activities to be performed during the remedial action. The SAP is attached as Appendix A of the Remediation Work Plan.

The SAP specifies the sampling protocols, analytical methods, and the types and numbers of samples to be collected during the remediation.

2.0 MEASUREMENT DATA ACQUISITION

The following Section describes tasks related to data acquisition. This includes the sampling process, quality control procedures and requirements, equipment operation, data management, and record keeping.

2.1 Sampling Process

Field personnel will collect samples of waste/soil, backfill soil, and soil from the excavation during this project. Samples will be handled under standard preservation and chain-of-custody procedures. Analytical methods and requirements for the project are listed in Table 2.1-1.

Table 2.1-1 Analytical Methods and Requirements

Parameter	Method	Reporting Limit	Sample Container	Holding Time	Preservation
Total Petroleum Hydrocarbon - Gasoline Range Organics	EPA Method 8015B	10 mg/kg	4 oz Glass	14 Days	Cool to 4° C
Total Petroleum Hydrocarbon - Diesel Range Organics	EPA Method 8015B	10 mg/kg	9 oz Glass	14 Days Extraction; 40 Days Analysis	Cool to 4° C
TCLP RCRA 8 Metals	EPA Method 1311 Extraction/6010 Analysis/Hg 7470	must be 1/10th of regulatory limit	16 oz Glass	28 Days	Cool to 4° C
Paint Filter Test	EPA Method 9095	1mL/hour	4 oz /Glass	NA	None
pH	SW9045C	0.01 s.u.	4 oz Glass	NA	Cool to 4° C

Attachment I of the QAPP provides the quality assurance manual for Pace Analytical Services. Project-specific SOPs are included in Attachment II of the QAPP.

2.2 Quality Control

Quality Control (QC) samples will include both field and laboratory samples, as described below.

2.2.1 Field Quality Assurance/Quality Control Sampling

Field QC samples will include blind duplicate samples and matrix spike/matrix spike duplicates. The purpose of analyzing QC samples is to meet DQOs specified in Section 1.5, above.

A field duplicate is a second sample (or measurement) collected at the same location as the original sample in immediate succession, and using identical collection techniques, and also managed in an identical manner during storage, transportation, and analysis as the original sample.

For soil and waste/soil samples, a sample will be chosen, split, and submitted as a field sample "duplicate." Field duplicates will be collected at a minimum of one per 20 samples for the entire remediation sampling event. Duplicate sample results are used to assess precision of the sample collection process, as well as serve as a check for laboratory precision. Field duplicates will be analyzed for the same suite of analytical parameters as the primary sample. The sample containers for field duplicate samples will be assigned a sample identification number such that they cannot be identified as duplicate samples by the laboratory.

There are no U.S. EPA criteria for evaluation of field duplicate sample comparability; however, the relative percent difference (RPD) between the original sample and field duplicate can be calculated for each parameter and compared to the precision goal. Field duplicate RPDs greater than the project-specified precision goal indicates a high variability associated within the sample.

Only decontaminated sampling equipment would require rinseate samples. New, never used sampling equipment does not require rinseate sampling. It is anticipated that only new, never used equipment (stainless steel spoons, plastic spoons, or similar) will be used for sample collection and therefore rinseate samples will not be collected.

A matrix spike (MS) and matrix spike duplicate (MSD) is an aliquot of sample fortified (spiked) in the laboratory with known concentrations of representative analytes of interest. The spiking occurs prior to sample preparation and analysis. MS/MSD data are used to document the bias of a method due to sample matrix. The MS/MSD sample will be designated on the Chain of Custody form. A minimum of one MS and one MSD sample shall be analyzed for every 20 environmental samples of a specified matrix.

2.2.2 Laboratory Quality Assurance/Quality Control

Laboratory quality control procedures for the selected laboratory (Pace Analytical Services) are contained in Attachment I of this QAPP.

2.3 Equipment Operation, Calibration, and Standardization

All field and laboratory equipment will be operated, maintained, calibrated, and standardized in accordance with EPA and manufacturers' recommended procedures. Applicable Standard Operating Procedures (SOPs) that specify field equipment operation, maintenance, calibration, and standardization procedures are contained in Attachment II of this QAPP. The selected analytical method(s) define QC requirements and how the laboratory must analyze each sample.

2.4 Data Management

Tetra Tech has the overall responsibility for data management. Analytical data will be provided to Tetra Tech in both electronic format and hard copy. Hard copy reports will be stored in the project files. Tetra Tech will manually enter laboratory and field parameter measurements into an excel spreadsheet and store on the Tetra Tech server. The Tetra Tech Casper office server is backed up at least daily.

Field observations and other Site data will be entered onto appropriate field forms and filed in designated project files at the Tetra Tech Casper office. The QA Officer will maintain quality control of data transfer into the database by verifying the accuracy of a minimum of 10% of the entries placed in the database.

2.5 Documents and Records

The Project Manager will be responsible for ensuring that project personnel have the current versions of the SAP and QAPP and other project planning documents. The Project Manager will also maintain current project files and project documents.

3.0 ASSESSMENT AND OVERSIGHT ELEMENTS

The Project Manager and QA Officer will be responsible for assessment and oversight of project activities. The Wyoming DEQ Project Manager will be updated daily when on-site remedial activities are being conducted.

An internal audit of field procedures may be performed by the QA Officer. If completed, the internal audit will include a review of procedures selected for the sampling program, a review of the QA/QC samples required, and a review of training requirements. The laboratory is required to have written procedures addressing internal QA/QC as specified in the Comprehensive Environmental Response Compensation Liability Act (CERCLA) Contract Lab Program (CLP) protocol.

Corrective actions will be implemented promptly upon identification of potential problems with data acquisition or measurement. Field equipment malfunctions will be identified promptly and corrected by the project field team. Corrective actions will be documented in the field notes. Laboratory equipment malfunctions are handled according to EPA analytical method specifications. Laboratory QC samples (calibration samples, method blanks, matrix spike samples, laboratory control samples, and laboratory duplicates) will be handled according to EPA analytical method specifications and the Contract Lab Program protocol. Laboratory corrective actions will be included on analytical laboratory reports.

4.0 DATA REVIEW, VERIFICATION, AND VALIDATION

4.1 Data Reduction

Data reduction, the result of grouping similar QC samples and calculating and reporting their recoveries, will be performed on laboratory data while still in the laboratory. Tetra Tech

personnel will work directly with the laboratory's data QA Officer who will review all analytical data associated with each sample. Tetra Tech will receive all QA/QC reports from the analytical laboratory.

The types of laboratory QC data reviewed will include calibration standards, calibration verification, laboratory controls, laboratory duplicates, and laboratory spikes. When EPA methods are used, the applicable data reduction procedures called for in the EPA methods will be used. The assessment reports will include the raw data and a summary of QC data reduction.

4.2 Data Review

The ability of data to meet DQOs is evaluated with a precision, accuracy, representativeness, completeness, and comparability (PARCC) statement. A PARCC statement is generated during data evaluation. The following sections define the terms used in the PARCC statement.

4.3 Precision

Precision is the amount of scatter or variance that occurs in repeated measurements of a particular analyte. Precision acceptance and rejection for this project will be based on the relative percent difference (RPD) of the field duplicates. Analytical results for the field and duplicate soil samples will be evaluated using the RPD between the two samples when both values of the field/duplicate pair are greater than five times the practical quantitation limit (PQL) for a given analyte.

4.3.1 Field Precision Objectives

Precision of sampling and analysis methods will be assessed through the collection of field duplicate samples. Field duplicates are collected to measure the sampling and analytical variability or imprecision associated with the sample results. The relative percent difference (RPD) in the results for each analyte will be computed for each field duplicate pair using the equation provided in Section 8.2.4, Analytical Duplicate Samples.

The goal for precision of field duplicate results is $\pm$ 50 percent RPD for soil samples. However, if one or both samples in a field duplicate pair have a concentration less than 10x the laboratory reporting limit (RL), the field precision goal will be $\pm$ 5 x the RL. It is noted here that natural variation in soil will affect how closely these goals are met; that is, if variation is high, then these goals may be unrealistic. Consequently, RPD results from field duplicates of soil samples will not be used as a basis of invalidating any analytical data.

4.3.2 Laboratory Precision Objectives

Precision of the analytical method will be assessed through duplicate analyses of laboratory QC and field samples. The relative percent difference (RPD) in the results for each analyte will be computed for each analytical duplicate pair using the equation provided in Section 8.2.3, Analytical Duplicate Samples.

Data for duplicate analysis will be evaluated only if both of the samples in the duplicate pair have a concentration greater than the laboratory RL. The limit for precision of laboratory analytical duplicates and MS/MSD is 35% RPD (soil samples) for samples >5x the RL.

4.4 Accuracy

Accuracy is defined as the ability of the analytical procedure to determine the actual or known quantity of a particular substance in a sample. Accuracy acceptance or rejection will be based on the percent recovery (%R) of the matrix spike (MS) for soil samples, and will be based on the percent recovery of the laboratory control sample (LCS) for solid samples.

To determine accuracy, the %R for each matrix spike or LCS will be compared to the acceptable range as specified in the applicable laboratory method. Equipment and laboratory blanks may also be analyzed to quantify artifacts introduced during sampling, transport or analysis that may affect the accuracy of the data. In addition, initial and continuing calibration results may be used to verify that the sample concentrations are accurately measured by the analytical instrument.

The percentage recovery for MS samples is given by:

$$\text{Recovery (\%)} = \frac{A - B \times 100}{T}$$

Where: A = measured concentration of the spiked sample;
B = concentration of unspiked sample; and
T = amount of spike added.

The percent recovery for surrogate standards and LCSs are given by:

$$\text{Recovery (\%)} = \frac{A}{T} \times 100$$

Where: A = measured concentration of the surrogate or LCS; and
T = known concentration.

Field sample results associated with percent recoveries outside acceptable limits will be considered estimated. Field sample results associated with percent recoveries of less than 50% will be considered rejected, as recommended by EPA (2004a and 2004b). An overall assessment of accuracy will be made upon completion of the project. Overall accuracy will be stated as the mean %R. Because of the small number of matrix spike and laboratory control samples anticipated, no confidence interval will be calculated. The range of acceptable accuracy is analyte specific.

4.5 Representativeness

The objective in addressing representativeness is to assess whether information obtained during the investigation accurately represents site conditions. Field results associated with contaminated blanks will be considered estimated, with a high bias, when the field sample result is greater than the practical quantification limit but less than five times the contaminant concentration, as recommended by EPA (2004a and 2004b).

If a laboratory blank contains detectable levels of common laboratory contaminants, then the sample results will be considered as positive only if the concentrations in the sample exceed 10 times the maximum amount detected in any blank. If the concentration in the sample is less than 10 times the blank concentration, we will conclude that the chemical was not detected in the sample and will consider the blank-related concentrations of the chemical to be the

quantification limit for the chemical in that sample. If all samples contain levels of a common lab contaminant at less than 10 times the contamination noted in the blank, then the analyte will be eliminated from the set of sample results.

4.6 Completeness

The objective in addressing completeness is to assess whether enough data have been collected and enough data are valid to meet the remediation needs. Completeness is assessed by comparing the number of valid sample results to the number of samples collected. The completeness goal of the project is 90%.

Percentage completeness (C) is given by:

$$C\ (\%) = \frac{V}{P} \times 100$$

Where: V = number of valid measurements/data points obtained; and
P = number of measurements/data points planned.

4.7 Comparability

The objective in addressing comparability is to assess whether one set of data can be compared to another set of data. Comparability is assessed by determining if an EPA-approved analytical method was used, if values and units are sufficient for the database, if specific sampling points can be established and documented, and if field collection methods were similar.

4.8 Data Validation and Evaluation

Data validation consists of completing a review of data using the raw analytical data. The laboratory will validate raw laboratory data using EPA Contract Laboratory Program (CLP) National Functional Guidelines and according to specific analytical method requirements. Data evaluation consists of completing a review of laboratory analytical reports that have already had internal laboratory validation of raw data.

The objective of data validation and evaluation is to identify any unreliable or invalid laboratory measurements and qualify data for interpretive use. For this project, the analytical laboratory will perform data validation on raw analytical data prior to preparing a final analytical report. Once the laboratory has prepared and submitted a final analytical report, project personnel will complete an evaluation of the data. The data evaluation will include review of field QA/QC data and additional review of qualifiers assigned to the data by the analytical laboratory. Additional qualifiers will be assigned to the data as necessary based on, but not limited to, precision and accuracy of results, blank contamination, and holding time exceedences.

Table 4.8-1 presents the data qualifiers that will be assigned to results, as necessary.

Table 4.8-1 Data Qualifiers	
Qualifier	Result
ND	The analyte was analyzed for but not detected at or above the PQL used for the method
U	Qualifier indicates this analyte was analyzed for, but not detected at or above the number indicated, which is the reporting limit for that sample.
J	Qualifier indicates this compound was detected but at a concentration below the quantitation limit. The result is therefore an estimated value.
B	Qualifier indicates this compound was found in the associated method blank. Under these conditions this value is regarded as an estimated value.

Project personnel will complete data evaluation checklists. The checklists provide a guide for review of the laboratory and field procedures and data collected. The review will evaluate whether the following were completed according to SAP/QAPP requirements, EPA guidelines and/or method specifications:

- Chain-of-custody procedures;
- Cooler temperatures;
- Holding times;
- Laboratory QA/QC (method blanks, control samples, duplicates, MS/MSD); and,
- Field QA/QC (sample handling, duplicates, and field and equipment blanks).

Knowing the limitations of the data assists the data user when making interpretations. Data with limitations are usable for evaluation as long as the limitations are considered. Evaluation of other field data (pH meter, for example) is not possible because these data have very limited statistical control limits. Professional judgment is required and will be used to assess the impact of field QC on the overall quality and usability of the field data.

4.9 Data Reconciliation

Data reconciliation is performed in the office after data validation is complete. Data reconciliation is the generation of the PARCC statement that assesses the data relative to meeting the DQOs. Tetra Tech will perform this reconciliation as part of the data evaluation and completion of the data evaluation checklist. Using the PARCC statement as a basis, reconciliation of data evaluation will be done by comparing evaluation results with project objectives. If data user requirements are not met, the Tetra Tech Project Manager and Quality Assurance Manager will confer with the Wyoming DEQ on how issues will be resolved and how limitations of the data will be reported.

5.0 SAMPLING PROCESS DESIGN

5.1 Sampling Locations and Frequencies

Waste/soil samples (field screening, verification samples, and confirmation samples) will be collected at locations and frequencies specified in the Sampling and Analysis Plan (Appendix A of the Remediation Work Plan).

5.2 Sampling Methods

Field sampling methods, equipment utilized, and decontamination procedures for this project are documented in the SOPs provided in Attachment II. The sampling procedures provided in the SOPs are designed to provide the type and quality of data consistent with the objectives of this project. Table 2.1-1 provides volume, container-type, preservation, and holding time specifications for each sample type and analytical method**.**

5.3 Sample Containers, Preservatives, and Holding Times

5.3.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, commercially-cleaned sample containers will be obtained from the analytical laboratory. The bottles will be labeled as described in the previous section.

5.3.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to ensure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping. Sample preservation requirements are presented in the project SAP and/or QAPP.

5.3.3 Sample Holding Times and Analyses

Sample holding times are established to minimize chemical changes in a sample prior to analysis and/or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and/or extraction, based on the nature of the analyte of interest and chemical stability factors. Applicable analyte holding times are listed in the project SAP and/or QAPP.

For most samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

5.4 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described in the previous discussion, and placed on ice in an insulated cooler. The sample containers will be placed in re-closeable

plastic storage bags. Samples will then be placed right side up in a cooler with double bagged ice for delivery to the laboratory. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal. Alternately, samples will be placed in a plastic bag and the bag will be sealed with a custody seal and placed into the cooler with bagged ice for shipment.

5.4.1 Sample Documentation and Tracking

This Section describes the information that should be provided in field notes and sample Chain-of-Custody documentation.

5.4.1.1 Field Notes

Documentation of observations and data acquired in the field provide information on sample acquisition, field conditions at the time of sampling, and a permanent record of field activities. Field observations and data collected during routine monitoring activities will be recorded with waterproof ink in a permanently bound weatherproof field log book or field data sheets with consecutively numbered pages as specified in the project SOPs.

Field notebook and/or data sheet entries will, at a minimum, include the information listed below. Relevant SOPs should be consulted to supplement this list.

- Project name;
- Location of sample;
- Data and time of sample collection;
- Sample identification numbers;
- Description of sample (matrix sampled);
- Sample depth (if applicable);
- Sample methods, or reference to the appropriate SOP;
- Field observations; and
- Personnel present.

Changes or deletions in the field book or on the data sheets should be recorded with a single strike mark, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without having to rely on the collector's memory.

All field books and field data sheets will be signed on a daily basis by the person who has made the entries. Anyone making entries in another person's field book will sign and date those entries.

5.4.1.2 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Establishment of traceability of data is crucial for resolving future problems if analytical results are called into question and for minimizing the possibility of sample mix-up. Initial information concerning collection of the samples will be recorded in the field log book or on data sheets as described above. Information on the custody, transfer, handling and shipping of samples will be recorded on a Chain-of-Custody (COC) form.

The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. A COC form will be completed for each set of samples collected, and will contain the following information:

- Sampler's signature and affiliation;
- Project number;
- Date and time of collection;
- Sample identification number;
- Sample type;
- Analyses requested;
- Number of containers;
- Signature of persons relinquishing custody, dates, and times;
- Signature of persons accepting custody, dates, and times;
- Any additional instructions to the laboratory.

The person responsible for delivery of the samples to the laboratory will sign the COC form, retain the third copy of the form, document the method of shipment, and send the original and the second copy of the form with the samples. Upon arrival at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project Manager. Copies of all COC documentation will be compiled and maintained in the central files. The original COC forms will remain with the samples until the time of final disposition. After returning samples for disposal, the laboratory will send a copy of the original COC to the Operator. This will then be incorporated into the central project files.

5.5 Laboratory Sample Handling and Custody

When the samples are received by the analytical laboratory, the COC will be immediately signed along with the date and time of receipt. The top sheet (white copy) or a copy of the COC may be returned with the final analytical report. The laboratory will follow appropriate chain-of-custody procedures when shipping any samples to a subcontracted laboratory for analysis.

Upon receipt by the laboratory, the samples will be inspected for sample integrity and preservation, including temperature. The COC will be reviewed to verify completeness. Any discrepancies between the COC and sample labels and any problems noted upon sample receipt will be communicated immediately to the Project Manager.

The laboratory will store the samples in a specially designated area which is clean and maintained at the appropriate preservation temperature. The laboratory will be responsible for following their internal custody procedures from the time of sample receipt until sample disposal.

Coolers containing samples are received and processed into the laboratory using the SOP from the selected laboratory, which is maintained on file at the facility. A Sample Receipt Checklist is generated providing documented details of the sample receipt including temperature of the cooler.

Acceptable cooler temperature is 4 $\pm$ 2°C. If a temperature deviation is discovered, it will be determined if the sample needs to be chilled. If sample preservation requires cooling, the samples will be immediately chilled to within the required temperature range.

The Project Manager will evaluate the length of time that the samples were likely out of the desired temperature range along with the actual temperature when discovered, to determine if the samples are suitable for analysis or should be discarded.

6.0 CALIBRATION PROCEDURES

6.1 Field Instruments and Equipment

Equipment used to gather, generate, or measure environmental data will be calibrated each day prior to use consistent with the manufacturer's specifications to ensure that the accuracy and reproducibility of the results are obtained.

Field sampling and measurement equipment will be examined to certify that it is in good operating condition. This includes checking the manufacturer's operating manual and the instructions for each instrument to ensure that maintenance requirements are being met. In the event that a field instrument cannot be calibrated to meet the manufacturer's specifications, it will be tagged "defective" and returned to the manufacturer or other supplier for service or replacement. Calibration procedures are also covered in the SAP and SOPs.

6.2 Laboratory Instruments

Instruments used by the laboratory will be calibrated in accordance with the laboratory's Quality Assurance Plan (QAP), method SOPs, and any specified EPA-method requirements. When laboratory measurement instruments do not meet the calibration criteria of the QAP, Method SOP or EPA method, then the instrument will not be used for analysis of samples submitted under this project QAPP. Calibration records and demonstration of acceptable calibration results should be accessible if requested by project personnel. Maintenance records will be available for inspection.

7.0 ANALYTICAL PROCEDURES

The analytical parameters, analytical methods, and required method detection limits for which the samples are to be analyzed for are summarized in Table 2.1-1, Analytical Methods and Requirements. Table 2.1-1 includes holding times, preservation guidelines, and required sample amounts for all samples.

A copy of this QAPP will be submitted to the laboratory before the first batch of samples is received. Procedures for laboratory analysis, with any modifications, should be further documented in the laboratory SOPs, which are maintained at the laboratory and are listed in the laboratory's QAP. The Pace Analytical Services Laboratory Quality Assurance Manual (QAM) and laboratory SOPs for applicable methods are presented in Attachment I of this QAPP.

8.0 FIELD AND LABORATORY QUALITY CONTROL

Quality control may be checked by collecting and analyzing field quality control (QC) samples and performing laboratory QC analyses. Both field and laboratory QC are necessary to control the sampling and analytical process, assess the accuracy and precision of results, and identify assignable causes for anomalous results.

8.1 Field Quality Control

To assess precision of field sampling and assure that contamination has not occurred in the field, the level of field QC effort includes the following samples.

8.1.1 Field Duplicate

A field duplicate is defined as a second sample (or measurement) from the same location, collected in immediate succession, using identical techniques. For soil samples, a sample will be chosen, split, and submitted as a field sample "duplicate". Field duplicates will be submitted at a minimum of one per 20 samples per the entire remediation sampling event. These samples will measure sample variability, as well as be a check for laboratory precision. Field duplicates will be analyzed for the same suite of analytical parameters as the primary sample.

There are no U.S. EPA criteria for evaluation of field duplicate sample comparability, however, the relative percent difference (RPD) between the original sample and field duplicate can be calculated for each parameter and compared to the precision goal. Field duplicate RPDs greater than the project-specified precision goal indicates a high variability associated within the sample.

8.1.2 Rinseate Blanks

Sampling equipment will most likely be new equipment and decontaminated equipment will not be used. Therefore rinseate samples will not be generated or collected.

8.2 Laboratory Quality Control

The appropriate type and frequency of laboratory quality control (QC) samples will be dependent on the sample type/media, analytical methods, and the laboratory's SOPs. With each

QC batch for sample analysis, the following laboratory QC samples will be analyzed in addition to the calibration samples.

8.2.1 Method Blank Samples

No target analytes should be found in laboratory blanks. Blank contamination, if found, will be evaluated using USEPA Contract Laboratory Program National Functional Guidelines for Inorganic Data Review (USEPA 2004) functional guidelines.

8.2.2 Matrix Spike Samples

Laboratory matrix spike samples are used to evaluate potential matrix effects on sample analysis for inorganic parameters. Percent recoveries of target analytes from matrix spike samples should fall within control limits of 70 to 130 percent for solid samples. However, if other QA/QC results are acceptable, there is no requirement to qualify sample results. Matrix interference and other effects may cause low or high percent recoveries in investigative samples; matrix effects may be noted at the same time that recoveries from laboratory control samples indicate acceptable method performance.

8.2.3 Analytical Duplicate Samples

Based on USEPA guidelines, laboratory replicate samples and the samples from which they are split should have relative percent differences (RPDs) whose absolute values do not exceed 35 percent (for solid samples) in cases where both sample values are greater than or equal to five times the reporting limit.

The RPD is defined by the following equation:

$$RPD = \frac{\text{sample} - \text{duplicate values}}{\left(\frac{\text{sample} + \text{duplicate values}}{2}\right)} \times 100\%$$

If one or both values are less than five times the reporting limit, the difference between the primary and replicate values should not exceed 2x the reporting limit for solid samples.

8.2.4 Frequency

Laboratory QA/QC samples method blank, matrix spike, and laboratory control samples should be run in a QC batch of one each per 20 field samples.

9.0 DATA REDUCTION, VALIDATION AND REPORTING

Field measurement values are generally reported directly in the units of final use in the field notebook or data sheets without need for additional calculations (e.g., pH and temperature).

The field data will be reviewed daily by the Field Team Supervisor to identify anomalous data and transcriptional and/or computational errors. Corrective actions will be initiated as appropriate; these actions may consist of re-measuring a particular parameter, collecting a new

sample, or other applicable corrective action measures. The laboratory's calculations and data review will be performed in accordance with procedures prescribed in their own QAP and the referenced analytical method.

9.1 Data Review and Validation

Validation means those processes taken independently of the data-generation processes to determine the usability of data for its intended use(s). All data obtained from field and laboratory measurements will be reviewed and verified for conformance to project requirements, and then validated against the data quality objectives that are listed in Section 1.5.

Laboratory results will be checked for completeness to assure that all the requested analyses were performed along with the correct methodologies and detection limits. Data will also be evaluated to assess whether the measurement performance criteria for accuracy and precision have been achieved. Laboratory method blanks, matrix spike samples, laboratory duplicate samples, laboratory control samples, and holding times will be validated. The laboratory will provide a QC summary.

The data to be verified are evaluated against project specifications and are checked for errors, especially errors in transcription, calculations, and data input. Any suspected errors or anomalous data will be addressed by the manager of the task associated with the data, before data validation can be completed.

Potential outliers are identified by the Project QA Manager and Project Manager by examining results for unreasonable data, or identified using computer-based statistical software. If a question arises or an error or potential outlier is identified, the Field Team Supervisor or the Laboratory Project Manager responsible for generating the data is contacted to resolve the issue. Issues that can be resolved are corrected and documented electronically or by initialing and dating the associated paperwork. If an issue cannot be corrected, the QA Manager consults with the Project Manager to determine the appropriate course of action, or the data associated with the issue are rejected.

9.2 Data Reporting Format

The laboratory reporting for the soil/waste analysis will include the following information. This information will be presented as an analytical hardcopy report in PDF file format and in addition, the data will also be reported as an electronic data deliverable.

- Sample identification number;
- Analytes, concentrations, and units;
- Analysis date;
- Analysis method used;
- Laboratory qualifiers and definitions.

The laboratory QC summary should include the following:

- Case Narrative;
- Method detection limits and sample dilution information;
- Laboratory quantification limits;
- Method blank data;
- Analytical duplicate data;
- Matrix spike data;
- Laboratory control sample data;
- Laboratory case narrative summarizing any method deviations or analysis problems;
- Sample log-in information.

Data reporting packages will be prepared by the Laboratory Project Manager and submitted to the Project Manager.

11.0 PREVENTATIVE MAINTENANCE

11.1 Routine Preventative Maintenance Procedures and Schedules

Field equipment will be cleaned and safely stored in between each use, and routine maintenance recommended by the equipment manufacturer will also be performed. Equipment will be inspected and the calibration checked (if applicable) before it is transported to a field setting for use.

Preventative maintenance of field equipment will include routine inspection and either calibration or testing as specified in the relevant SOP or manufacturer's instructions.

Laboratory preventative maintenance will include routine equipment inspection and calibration at the beginning of each day or each analytical batch, per the laboratory's internal SOPs and method requirements.

11.2 Field Instruments and Equipment

Equipment will be inspected before use and field instruments that fail calibration requirements will be tagged as "nonfunctional" or "defective" and returned to the manufacturer or other supplier for repair or replacement. Field equipment that is worn or not functioning will be replaced immediately.

11.3 Laboratory Instruments

Instruments used by the laboratory will be maintained in accordance with the laboratory's QAP and method requirements. The laboratory will keep maintenance records and make them available for review, if requested, during laboratory audits.

12.0 SPECIFIC ROUTINE PROCEDURES TO ASSESS DATA

12.1 Field Measurement Data

Both quantitative and qualitative field data will be obtained for use in the project. For quantitative field measurements, accuracy is usually confirmed through routine calibration of measurement equipment. Measurement precision may be evaluated through replicate measurements.

Field completeness is defined as a measure of the amount of valid data obtained from a measurement system compared to the amount that was expected to be obtained under normal conditions.

Field measurement data will be reviewed daily before its incorporation into the project database. Questionable results will be addressed through a timely and appropriate corrective action (Section 13.0). Once field data have been approved for incorporation into the project database, the data will also be considered acceptable for use in the project.

12.2 Laboratory Data

As discussed in previous sections of this QAPP, the accuracy, precision, completeness, and representativeness of analytical data will be described relative to the project's control limits. The data quality review will be documented in reports to the Project Manager and any qualification of the data resulting from that review will be attached to results that are incorporated into the project database so that all data users are aware of data quality for individual results.

13.0 CORRECTIVE ACTIONS

Corrective action is the process of identifying, recommending, approving, and implementing measures to counter unacceptable procedures or poor QC performance which can affect data quality. Corrective action can occur during field activities, laboratory analyses, data validation, and data assessment. Proposed corrective actions will be documented as well as the steps taken to implement the corrective action. Corrective action should only be implemented after approval by the Project Manager. If immediate corrective action is required, approvals secured by telephone from the Project Manager should be documented.

Nonconforming equipment, items, activities, conditions, and unusual incidents that could affect data quality and attainment of the project's quality objectives will be identified, controlled, and reported in a timely manner. For the purpose of this QAPP, a nonconformance is defined as a malfunction, failure, deficiency, or deviation that renders the quality of an item unacceptable or indeterminate in meeting the project's quality objectives.

If the analytical results from laboratory QC samples fall outside of the measurement performance criteria, corrective actions should be initiated immediately by the laboratory. If the laboratory cannot correct the situation that caused the nonconformance and an out-of-control situation continues to occur or is expected to occur, then the laboratory will immediately contact the Project QA Manager and request instructions regarding how to proceed with sample analyses. Completion of any corrective action should be evidenced by data once again falling within prescribed measurement performance criteria. If an error in laboratory procedures or sample collection and handling procedures cannot be found, the results will be reviewed by the

Project QA Manager and Project Manager to assess whether reanalysis or re-sampling is required.

The need for corrective action may be identified during either data validation or data assessment. Potential types of corrective action may include resampling or reanalysis of samples. These actions are dependent upon the ability to mobilize the field team and whether the data to be collected are necessary to meet the required QA objectives. If the Project QA Manager identifies a corrective action situation, it is the Project Manager who will be responsible for approving the implementation of corrective action. All corrective actions of this type will be documented by the Project QA Manager.

Any corrective actions taken will be documented in writing by either the Laboratory QA Manager or the Project QA Manager and reported to the Project Manager. Corrective action records will be included in the project files.

Attachment I

Laboratory Quality Assurance Manual

QUALITY ASSURANCE MANUAL

Quality Assurance/Quality Control Policies and Procedures

Pace Analytical Services, Inc. – Minnesota
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Pace Analytical Services, Inc. – Montana
602 South 25th Street, Billings, Montana 59101

CORPORATE APPROVAL

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2-2-2012
Date

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Effective Date is the date of the last signature

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Date: 2-7-12

Client Services Manager
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Date: 2/2/2012

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1.0. INTRODUCTION AND ORGANIZATIONAL STRUCTURE

"Working together to protect our environment and improve our health"
Pace Analytical Services Inc. - Mission Statement

1.1. Introduction to PASI

Pace Analytical Services, Inc. (PASI) is a privately held, full-service analytical testing firm operating a nationwide system of laboratories. PASI offers extensive services beyond standard analytical testing, including: bioassay for aquatic toxicity, air toxics, industrial hygiene testing, explosives, dioxins and coplanar PCB's by high resolution mass spectroscopy , radiochemical analyses, product testing, pharmaceutical testing, field services and mobile laboratory capabilities. PASI has implemented a consistent Quality System in each of its laboratories and service centers. In addition, the company utilizes an advanced data management system that is highly efficient and allows for flexible data reporting. Together, these systems ensure data reliability and superior on-time performance. This document defines the Quality System and QA/QC protocols.

Our goal is to combine our expertise in laboratory operations with customized solutions to meet the specific needs of our customers.

1.2. Statement of Purpose

To meet the business needs of our customers for high quality, cost-effective analytical measurements and services.

1.3. Quality Policy Statement and Goals of the Quality System

PASI management is committed to maintaining the highest possible standard of service for our customers by following a documented quality system. The overall objective of this quality system is to provide reliable data of known quality through adherence to rigorous quality assurance policies and quality control procedures as documented in this Quality Assurance Manual.

All personnel within the PASI network are required to be familiar with all facets of the quality system relevant to their position and implement these policies and procedures in their daily work. This daily focus on quality is applied with initial project planning, continued through all field and laboratory activities, and is ultimately included in the final report generation.

PASI management demonstrates its commitment to quality by providing the resources, including facilities, equipment, and personnel to ensure the adherence to these documented policies and procedures and to promote the continuous improvement of the quality system. All PASI personnel must comply with all current applicable state, federal, and industry standards, such as the NELAC, TNI, NVLAP, and ISO 17025 standards, and are required to perform all tests in accordance with stated methods and customer requirements.

1.4. Core Values

- **Integrity-** Pace personnel are required to abide by the PASI Code of Ethics and all Pace employees must go through Data Integrity/Ethics training upon initial orientation and as an annual refresher.
- **Value Employees-** Pace management views employees as our most important asset and communicates to them the relevance and importance of their activities within their job functions and how they contribute to the achievement of the objectives of the quality management system.
- **Know Our Customers-** Pace makes every effort to know our customers and address their sampling and analytical needs. More information on this item can be found in section 2.0.
- **Honor Commitments-** Pace labs focus on making solid commitments with regards to quality, capacity, and agreed upon turnaround time to our customers.
- **Flexible Response To Demand-** Pace labs are equipped with both the material and personnel resources to enable them to be responsive to the demands of customers when situations or projects need change.
- **Pursue Opportunities-** Pace is committed to pursuing opportunities for the growth of the company by constantly exploring markets and areas where we can expand.
- **Continuously Improve-** Pace has committed much time and effort into establishing a continuous improvement program where company personnel meet on a regular basis to share ideas in cost reduction, production improvement and standardization in order to develop best practices. This information, as well as company financial and production metrics, are tracked, evaluated, and shared with each Pace facility.

1.5. Code of Ethics

PASI's fundamental ethical principles are as follows:

- Each PASI employee is responsible for the propriety and consequences of his or her actions;
- Each PASI employee must conduct all aspects of Company business in an ethical and strictly legal manner, and must obey the laws of the United States and of all localities, states and nations where PASI does business or seeks to do business;
- Each PASI employee must reflect the highest standards of honesty, integrity and fairness on behalf of the Company with customers, suppliers, the public, and one another.
- Each PASI employee must recognize and understand that our daily activities in environmental laboratories affect public health as well as the environment and that environmental laboratory analysts are a critical part of the system society depends upon to improve and guard our natural resources:

Strict adherence by each PASI employee to this Code of Ethics and to the Standards of Conduct is essential to the continued vitality of PASI and to continue the pursuit of our common mission to protect our environment and improve our health.

Failure to comply with the Code of Ethics and Standards of Conduct will result in disciplinary action up to and including termination and referral for civil or criminal prosecution where appropriate. An employee will be notified of an infraction and given an opportunity to explain, as prescribed under current disciplinary procedures.

1.6. Standards of Conduct

1.6.1. Data Integrity

The accuracy and integrity of the analytical results and its supporting documentation produced at PASI are the cornerstones of the company. Lack of data integrity is an assault on our most basic values putting PASI and its employees at grave financial and legal risk and will not be tolerated. Therefore, employees are to accurately prepare and maintain all technical records, scientific notebooks, calculations, and databases. Employees are prohibited from making false entries or misrepresentations of data for any reason.

Managerial staff must make every effort to ensure that personnel are free from any undue pressures that may affect the quality or integrity of their work including commercial, financial, over-scheduling, and working condition pressures.

1.6.2. Confidentiality

PASI employees must not use or disclose confidential or proprietary information except when in connection with their duties at PASI. This is effective over the course of employment and for an additional period of two years thereafter.

Confidential or proprietary information, belonging to either PASI and/or its customers, includes but is not limited to test results, trade secrets, research and development matters, procedures, methods, processes and standards, company-specific techniques and equipment, marketing and customer information, inventions, materials composition, etc.

1.6.3. Conflict of Interest

PASI employees must avoid situations that might involve a conflict of interest or could appear questionable to others. The employee must be careful in two general areas:

- Participation in activities that conflict or appear to conflict with the employees' PASI responsibilities.
- Offering or accepting anything that might influence the recipient or cause another person to believe that the recipient may be influenced to behave or in a different manner than he would normally. This includes bribes, gifts, kickbacks, or illegal payments.

Employees are not to engage in outside business or economic activity relating to a sale or purchase by the Company. Other problematic activities include service on the Board of Directors of a competing or supplier company, significant ownership in a competing or supplier company, employment for a competing or supplier company, or participation in any outside business during the employee's work hours.

1.6.4. Compliance

All employees are required to read, understand, and comply with the various components of the standards listed in this document. As confirmation that they understand their responsibility, each employee is required to sign an acknowledgment form annually that then becomes part of the

employee's permanent record. Employees will be held accountable for complying with the Quality Systems as summarized in the Quality Assurance Manual.

1.7. Laboratory Organization

The PASI Corporate Office centralizes company-wide accounting, business development, financial management, human resources development, information systems, marketing, quality, safety, and training activities. PASI's Director of Quality is responsible for assisting the development, implementation and monitoring of quality programs for the company. See Attachment IIB for the Corporate Organizational structure.

Each laboratory within the system operates with local management, but all share common systems and receives support from the Corporate Office.

A General Manager (GM) supervises each regional laboratory. Some operations may have an Assistant General Manager (AGM) in situations where the General Manager is responsible for multiple laboratory facilities and is not necessarily in the facility on a regular basis. Quality Managers (QM) at each laboratory report directly to their General Manager or Assistant General Manager and will also receive guidance and direction from the Director of Quality.

The General Manager bears the responsibility for the laboratory operations and serves as the final, local authority in all matters. In the absence of the General Manager or Assistant General Manager, the Quality Manager serves as the next in command. He or she assumes the responsibilities of the GM until the GM is available to resume the duties of their position. In the absence of the GM and QM, management responsibility of the laboratory is passed to the Laboratory Operations Manager, however named, – provided such a position is identified – and then to the most senior department manager until the return of the GM or QM. The most senior department manager in charge may include the Client Services Manager or the Administrative Business Manager at the discretion of the General Manager.

A Laboratory Operations Manager or Technical Director who is absent for a period of time exceeding 15 consecutive calendar days shall designate another full-time staff member meeting the qualifications of the technical director to temporarily perform this function. The laboratory General Manager or Quality Manager has the authority to make this designation in the event the existing Laboratory Operations Manager or Technical Director is unable to do so. If this absence exceeds 35 consecutive calendar days, the primary accrediting authority shall be notified in writing.

The Quality Manager has the responsibility and authority to ensure the Quality System is implemented and followed at all times. In circumstances where a laboratory is not meeting the established level of quality or following the policies set forth in this Quality Assurance Manual, the Quality Manager has the authority to halt laboratory operations should he or she deem such an action necessary. The QM will immediately communicate the halting of operations to the GM and keep him or her posted on the progress of corrective actions. In the event the GM and QM are not in agreement as to the need for the suspension, the Chief Operating Officer and Director of Quality will be called in to mediate the situation.

Under the direction of the General Manager, the technical staff of the laboratory is generally organized into the following functional groups:

- Organic Sample Preparation
- Wet Chemistry Analysis
- Metals Analysis
- Volatiles Analysis
- Semi-volatiles Analysis
- Radiochemical Analysis
- Microbiology
- Air Analysis
- HRMS Analysis
- Process Testing

Appropriate support groups are present in each laboratory. The actual organizational structure for PASI – Minnesota and Montana is listed in Attachment IIA. In the event of a change in General Manager, Quality Manager, or any Laboratory Operations Manager/Technical Director, the laboratory will notify its accrediting authorities and revise the organizational chart in the Quality Assurance Manual (QAM) within 30 days. For changes in Department Managers or Supervisors or other laboratory personnel, no notifications will be sent to the laboratory's accrediting agencies; changes to the organizational chart will be updated during or prior to the annual review process. Changes or additions in these key personnel will also be noted by additional signatures on the Quality Manual, as applicable. In any case, the QAM will remain in effect until the next scheduled revision.

1.8. Laboratory Job Descriptions

1.8.1. Senior General Manager

- Oversees all functions of all the operations within their designated region;
- Oversees the development of local General Managers within their designated region;
- Oversees and authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Oversees the preparation of budgets and staffing plans for all operations within their designated region;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.2. General Manager (local laboratory)

- Oversees all functions of the operations;
- Authorizes personnel development including staffing, recruiting, training, workload scheduling, employee retention and motivation;
- Prepares budgets and staffing plans;
- Monitors the Quality Systems of the laboratory and advises the Quality Manager accordingly;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.3. Laboratory Operations Manager

- In the absence of the GM, performs all duties as listed above for the General Manager;
- Oversees the daily production and quality activities of all departments;
- Manages all departments and works with staff to ensure department objectives are met;
- Works with all departments to ensure capacity and customer expectations are accurately understood and met;

- Works with General Manager to prepare appropriate budget and staffing plans for all departments;
- Responsible for prioritizing personnel and production activities within all departments;
- Performs formal and informal performance reviews of departmental staff.

1.8.4 Quality Manager

- Oversees the laboratory Quality Systems while functioning independently from laboratory operations. Reports directly to the General Manager;
- Monitors Quality Assurance policies and Quality Control procedures to ensure that the laboratory achieves established standards of quality;
- Maintains records of quality control data and evaluates data quality;
- Conducts periodic internal audits and coordinates external audits performed by regulatory agencies or customer representatives;
- Operate as the designated data integrity officer, retain and investigate confidential reporting of instances of improper, unethical or illegal activities.
- Reviews and maintains records of proficiency testing results;
- Maintains the document control system;
- Assists in development and implementation of appropriate training programs;
- Provides technical support to laboratory operations regarding methodology and project QA/QC requirements;
- Maintains certifications from federal and state programs;
- Ensures compliance with all applicable state, federal and industry standards;
- Maintains the laboratory training records, including those in the Learning Management System (LMS);
- Monitors correctives actions;
- Maintains the currency of the Quality Manual.

1.8.5 Technical Director

- Monitors the standards of performance in quality assurance and quality control data;
- Monitors the validity of analyses performed and data generated;
- Reviews tenders, contracts and QAPPs to ensure the laboratory can meet the data quality objectives for any given project;
- Provides technical guidance in the review, development, and validation of new methodologies.

1.8.6 Administrative Business Manager

- Responsible for financial and administrative management for the entire facility;
- Provides input relative to tactical and strategic planning activities;
- Organizes financial information so that the facility is run as a fiscally responsible business;
- Works with staff to confirm that appropriate processes are put in place to track revenues and expenses;
- Provide ongoing financial information to the General Manager and the management team so they can better manage their business;

- Utilizes historical information and trends to accurately forecast future financial positions;
- Works with management to ensure that key measurements are put in place to be utilized for trend analysis—this will include personnel and supply expenses, and key revenue and expense ratios;
- Works with General Manager to develop accurate budget and track on an ongoing basis;
- Works with entire management team to submit complete and justified capital budget requests and to balance requests across departments;
- Works with project management team and administrative support staff to ensure timely and accurate invoicing.

1.8.7 Client Services Manager

- Oversees all the day to day activities of the Client Services Department which includes Project Management and, possibly, Sample Control;
- Responsible for staffing and all personnel management related issues for Client Services;
- Serves as the primary senior consultant to customers on all project related issues such as set up, initiation, execution and closure;
- Performs or is capable of performing all duties listed for that of Project Manager.

1.8.8 Project Manager

- Coordinates daily activities including taking orders, reporting data and analytical results;
- Serves as the primary technical and administrative liaison between customers and PASI;
- Communicates with operations staff to update and set project priorities;
- Provides results to customers in the requested format (verbal, hardcopy, electronic, etc.);
- Works with customers, laboratory staff, and other appropriate PASI staff to develop project statements of work or resolve problems of data quality;
- Responsible for solicitation of work requests, assisting with proposal preparation and project initiation with customers and maintain customer records;
- Mediation of project schedules and scope of work through communication with internal resources and management;
- Responsible for preparing routine and non-routine quotations, reports and technical papers;
- Interfaces between customers and management personnel to achieve customer satisfaction;
- Manages large-scale complex projects;
- Supervises less experienced project managers and provide guidance on management of complex projects;
- Arranges bottle orders and shipment of sample kits to customers;
- Verifies login information relative to project requirements and field sample Chains-of-Custody.

1.8.9 Project Coordinator

- Responsible for preparation of project specifications and provides technical/project support;
- Coordinates project needs with other department sections and assists with proposal preparation;
- Prepares routine proposals and invoicing;

- Responsible for scanning, copying, assembling and binding final reports;
- Other duties include filing, maintaining forms, process outgoing mail, maintaining training database and data entry.

1.8.10 Department Manager/Supervisor

- Oversees the day-to-day production and quality activities of their assigned department;
- Ensures that quality assurance and quality control criteria of analytical methods and projects are satisfied;
- Assesses data quality and takes corrective action when necessary;
- Approves and releases technical and data management reports;
- Ensures compliance with all applicable state, federal and industry standards.

1.8.11 Group Supervisor/Leader

- Trains analysts in laboratory operations and analytical procedures;
- Organizes and schedules analyses with consideration for sample holding times;
- Implements data verification procedures by assigning data verification duties to appropriate personnel;
- Evaluates instrument performance and supervises instrument calibration and preventive maintenance programs;
- Reports non-compliance situations to laboratory management including the Quality Manager.

1.8.12 Laboratory Analyst

- Performs detailed preparation and analysis of samples according to published methods and laboratory procedures;
- Processes and evaluates raw data obtained from preparation and analysis steps;
- Generates final results from raw data, performing primary review against method criteria;
- Monitors quality control data associated with analysis and preparation. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks;
- Reports data in LIMS, authorizing for release pending secondary approval;
- Conducts routine and non-routine maintenance of equipment as required;
- Performs or is capable of performing all duties associated with that of Laboratory Technician.

1.8.13 Laboratory Technician

- Prepares standards and reagents according to published methods or in house procedures;
- Performs preparation and analytical steps for basic laboratory methods;
- Works under the direction of a Laboratory Analyst on complex methodologies;
- Assists Laboratory Analysts on preparation, analytical or data reduction steps for complex methodologies;
- Monitors quality control data as required or directed. This includes examination of raw data such as chromatograms as well as an inspection of reduced data, calibration curves, and laboratory notebooks.

1.8.14 Sample Management Personnel

- Signs for incoming samples and verifies the data entered on the Chain of custody forms;
- Enters the sample information into the Laboratory Information Management System (LIMS) for tracking and reporting;
- Stages samples according to EPA requirements;
- Assists Project Managers and Coordinators in filling bottle orders and sample shipments.

1.8.15 Systems Administrator or Systems Manager

- Assists with the creation and maintenance of electronic data deliverables (EDDs);
- Coordinates the installation and use of all hardware, software and operating systems;
- Performs troubleshooting on all aforementioned systems;
- Trains new and existing users on systems and system upgrades;
- Maintains all system security passwords;
- Maintains the electronic backups of all computer systems.

1.8.16 Quality Assurance Analyst

- Assigned direct oversight, under supervision of the Quality Manager, of sections of the Laboratory Quality Systems for development, implementation and maintenance;
- Oversight of Laboratory Certifications, maintaining and acquiring new certification based on client and project needs and regulatory changes. Works with agencies and reports any regulatory or certification changes to Quality Manager;
- Oversight of Performance Testing (PT) Studies working with the laboratory to order and report results as needed;
- Oversight of controlled documents including numbering, tracking new documents and supplying logbooks as required;
- Maintains calibration of temperature monitoring support equipment

1.8.17 Safety/Chemical Hygiene Officer

- Maintains the laboratory Chemical Hygiene Plan;
- Plans and implements safety policies and procedures;
- Maintains safety records;
- Organizes and/or performs safety training;
- Performs safety inspections and provides corrective/preventative actions;
- Assists personnel with safety issues.

1.8.18 Program Director/Hazardous Waste Coordinator (or otherwise named)

- Evaluates waste streams and helps to select appropriate waste transportation and disposal companies;
- Maintains complete records of waste disposal including waste manifests and state reports;

- Assists in training personnel on waste-related issues such as waste handling and storage, waste container labeling, proper satellite accumulation, secondary containment, etc.;
- Conducts a weekly inspection of the waste storage areas of the laboratory.

1.9 Training and Orientation

Training for Pace employees is managed through a web-based Learning Management System. After a new employee has been instructed in matters of human resources, they are given instructional materials for the LMS and a password for access.

A new hire training checklist is provided to the new employee that lists training items for the employee to work through either independently on LMS or with their supervisor or trainer. The training items that can be completed independently include:

- Reading through applicable Standard Operating Procedures;
- Reviewing the Quality Manual and Chemical Hygiene Plan;
- Core training modules such as quality control indicators, basic laboratory skills, etc.;
- Quality Systems training including traceability of measurements, method calibration, calibration verification, accuracy, precision and uncertainty of measurements, corrective actions, documentation, and root cause analysis;
- Data Integrity/Ethics training.

The new employee's Department Supervisor provides the employee with a basic understanding of the role of the laboratory within the structure of PASI and the basic elements of that individual's position. Supervised training uses the following techniques:

- Hands-on training
- Training checklists/worksheets
- Lectures and training sessions
- Method-specific training
- Conferences and seminars
- Short courses
- Specialized training by instrument manufacturers
- Proficiency testing programs.
- On-line courses

Group Supervisors/Leaders are responsible for providing documentation of training and proficiency for each employee under their supervision. The employee's training file indicates what procedures an analyst or a technician is capable of performing, either independently or with supervision. The files also include documentation of continuing capability, which are fully detailed in Section 3.4. Training documentation files for each person are maintained by the Quality Office either in hardcopy format or within the LMS.

All procedures and training records are maintained and available for review during laboratory audits. These procedures are reviewed/updated periodically by laboratory management. Additional information can be found in SOP S-ALL-Q-020 ***Training Procedures*** or its equivalent revision or replacement.

1.10 Data Integrity System

The data integrity system at PASI provides assurances to management that a highly ethical approach is being applied to all planning, training and implementation of methods. Data integrity is crucial to the success of our company and Pace Analytical is committed to creating and maintaining a culture of quality throughout the organization. To accomplish this goal, PASI has implemented a data integrity system that encompasses the following four requirements:

1. A data integrity training program: standardized training is given to each new employee and a yearly refresher is presented to all employees. Key topics addressed by this training include:
   a. Need for honesty and transparency in analytical reporting
   b. Process for reporting data integrity issues
   c. Specific examples of unethical behavior and improper practices
   d. Documentation of non-conforming data that is still useful to the data user
   e. Consequences and punishments for unethical behavior
   f. Examples of monitoring devices used by management to review data and systems
2. Signed data integrity documentation for all employees: this includes a written quiz following the Ethics training session and written agreement to abide by the Code of Ethics and Standards of Conduct explained in the employee manual.
3. In-depth, periodic monitoring of data integrity including peer data review and validation, internal raw data audits, proficiency testing studies, etc.
4. Documentation of any review or investigation into possible data integrity infractions. This documentation, including any disciplinary actions involved, corrective actions taken, and notifications to customers must be available for review for laboratory assessors and must be retained for a minimum of five years.

PASI management makes every effort to ensure that personnel are free from any undue pressures that affect the quality of their work including commercial, financial, over scheduling, and working condition pressures.

Corporate management also provides all PASI facilities a mechanism for confidential reporting of data integrity issues that ensures confidentiality and a receptive environment in which all employees are comfortable discussing items of ethical concern. The anonymous message line is monitored by the Corporate Director of Quality who will ensure that all concerns are evaluated and, where necessary, brought to the attention of executive management and investigated. **The message line voice mail box number is available in the Pace Employee Handbook.**

1.11 Laboratory Safety

It is the policy of PASI to make safety and health an integral part of daily operations and to ensure that all employees are provided with safe working conditions, personal protective equipment, and requisite training to do their work without injury. Each employee is responsible for his/her own safety as well as those working in the immediate area by complying with established company rules and procedures. These rules and procedures as well as a more detailed description of the employees' responsibilities are contained in the corporate Safety Manual and Chemical Hygiene Plan.

1.12 Security and Confidentiality

Security is maintained by controlled access to laboratory buildings. Exterior doors to laboratory buildings remain either locked or continuously monitored by PASI staff. Keyless door lock combinations and computer access codes/logins are changed periodically. Posted signs direct visitors to the reception office and mark all other areas as off limits to unauthorized personnel. All visitors, including PASI staff from other facilities, must sign the Visitor's Logbook maintained by the receptionist. A staff member will accompany them during the duration of their stay on the premises unless the GM, QM, LOM or TD specify otherwise. In this instance, the staff member will escort the visitor back to the reception area at the end of his/her visit where he/she signs out. The last staff member to leave their department for the day should ensure that all outside access points to that area are secure.

Additional security is provided where necessary, e.g., specific secure areas for sample, data, and customer report storage, as requested by customers or cases where national security is of concern. These areas are lockable within the facilities, or are securely offsite. Access is limited to specific individuals or their designees. Security of sample storage areas is the responsibility of the Sample Custodian. Security of samples and data during analysis and data reduction is the responsibility of Group Supervisors. Security of customer report archives is the responsibility of the Client Services Manager. These secure areas are locked whenever these individuals or their designees are not present in the facility.

Access to designated laboratory sample storage locations is limited to authorized personnel only. Provisions for lock and key access are provided. No samples are to be removed without proper authorization. If requested by customer or contract, samples are not to be removed from secure storage areas without filling out an associated internal chain of custody.

Standard business practices of confidentiality are applied to all documents and information regarding customer analyses. Specific protocols for handling confidential documents are described in PASI SOPs. Additional protocols for sample identification by internal laboratory identification numbers only are implemented as required under contract specific Quality Assurance Project Plans (QAPPs).

All information pertaining to a particular customer, including national security concerns will remain confidential. Data will be released to outside agencies only with written authorization from the customer or where federal or state law requires the company to do so.

2.0. SAMPLE CUSTODY

2.1. Sampling Support

Each individual PASI laboratory provides shipping containers, properly preserved sample containers, custody documents, and field quality control samples to support field-sampling events. Guidelines for sample container types, preservatives, and holding times for a variety of methods are listed in Attachment VIII. Note that all analyses listed are not necessarily performed at all PASI laboratories and there may be additional laboratory analyses performed that are not included in these tables. PASI – Minneapolis and Montana may provide pick-up and delivery services to their customers when needed.

2.2. Field Services

Pace Analytical has a large Field Services Division which is based in their Minneapolis facility as well as limited field service capabilities in some of our other facilities. Field Services provides comprehensive nationwide service offerings including:

- Stack Testing
- Ambient Air
- CEM Certification Testing
- Air Quality Monitoring
- Onsite Analytical Services- FTIR and GC
- Real-time Process Diagnostic/Optimization Testing
- Wastewater, Groundwater and Drinking Water Monitoring
- Storm Water and Surface Water Monitoring
- Soil and Waste Sampling
- Mobile Laboratory Services

Field Services operates under the PASI Corporate Quality System, with applicable and necessary provisions to address the activities, methods, and goals specific to Field Services. All procedures and methods used by Field Services are documented in Standard Operating Procedures and Procedure Manuals.

2.3. Project Initiation

Prior to accepting new work, the laboratory reviews its performance capability. The laboratory confirms that sufficient personnel, equipment capacity, analytical method capability, etc., are available to complete the required work. Customer needs, certification requirements, and data quality objectives are defined and the appropriate sampling and analysis plan is developed to meet the project requirements by project managers or sales representatives. Members of the management staff review current instrument capacity, personnel availability and training, analytical procedures capability, and projected sample load. Management then informs the sales and client services personnel whether or not the laboratory can accept the new project via written correspondence, email, and/or daily operations meetings.

The laboratory maintains records of all such reviews, including discussions with customers. Routine analytical project documentation of quotes, notes, dates, initials, and/or recordings is maintained in a

project folder by project management. Conditions for new and more complex contracts are determined by the General Managers and sales representatives. Quality Management is consulted on technical requirements and operations staff provides input on volume capacities. Evidence of these reviews is maintained in the form of awarded Request for Proposals (RFPs), signed quotes or contracts, and a Customer Relationship Management (CRM) database. If a review identifies a potential mismatch between customer requirements and laboratory capabilities and/or capacities, Pace will specify its level of commitment by listing these exceptions to the requirements within the RFP, quote or contract.

Additional information regarding specific procedures for reviewing new work requests can be found in SOP S-ALL-C-006 ***Review of Analytical Requests*** or its equivalent revision or replacement.

2.4. Chain of Custody

A chain of custody (COC) provides the legal documentation of samples from time of collection to completion of analysis. PASI has implemented Standard Operating Procedures to ensure that sample custody traceability and responsibility objectives are achieved for every project.

Field personnel or client representatives must complete a chain of custody for all samples that are received by the laboratory. The importance of completeness of COCs is stressed to the samplers and is critical to efficient sample receipt and to insure the requested methods are used to analyze the correct samples.

If sample shipments are not accompanied by the correct documentation, the Sample Receiving department notifies a Project Manager. The Project Manager then obtains the correct documentation/information from the customer in order for analysis of samples to proceed.

The sampler is responsible for providing the following information on the chain of custody form:

- Customer project name
- Project location or number
- Field sample number/identification
- Date and time sampled
- Sample matrix
- Preservative
- Requested analyses
- Sampler signature
- Relinquishing signature
- Date and time relinquished
- Sampler remarks as needed
- Custody Seal Number if present
- Regulatory Program Designation
- The state where the samples were collected to ensure all applicable state requirements are met
- Turnaround time requested
- Purchase order number

The COC is filled out completely and legibly with indelible ink. Errors are corrected by drawing a single line through the initial entry and initialing and dating the change. All transfers of samples are

recorded on the chain of custody in the "relinquished" and "received by" sections. All information except signatures is printed.

Additional information can be found in S-MN-C-001 ***Sample Management*** or its equivalent revision or replacement.

2.5. Sample Acceptance Policy

In accordance with regulatory guidelines, PASI complies with the following sample acceptance policy for all samples received.

If the samples do not meet the sample receipt acceptance criteria outlined below, the laboratory is required to document all non-compliances, contact the customer, and either reject the samples or fully document any decisions to proceed with analyses of samples which do not meet the criteria. Any results reported from samples not meeting these criteria are appropriately qualified on the final report.

All samples must:

- Have unique customer identification that is clearly marked on durable waterproof labels affixed to the sample containers that match the chain of custody.
- Have clear documentation on the chain of custody related to the location of the sampling site with the time and date of sample collection.
- Have the sampler's name and signature.
- Have all requested analyses clearly designated on the COC.
- Have clear documentation of any special analytical or data reporting requirements.
- Be in appropriate sample containers with clear documentation of the preservatives used.
- Be correctly preserved unless the method allows for laboratory preservation.
- Be received within holding time. Any samples with hold times that are exceeded will not be processed without prior customer approval.
- Have sufficient sample volume to proceed with the analytical testing. If insufficient sample volume is received, analysis will not proceed without customer approval.
- Be received within appropriate temperature ranges - not frozen but ≤6°C [(See Note 1)], unless program requirements or customer contractual obligations mandate otherwise [(see Note 2)]. The cooler temperature is recorded directly on the COC and the SCUR. Samples that are delivered to the laboratory immediately after collection are considered acceptable if there is evidence that the chilling process has been started. For example, by the arrival of the samples on ice. If samples arrive that are not compliant with these temperature requirements, the customer will be notified. The analysis will NOT proceed unless otherwise directed by the customer. If less than 72 hours remain in the hold time for the analysis, the analysis may be started while the customer is contacted to avoid missing the hold time. Data associated with any deviations from the above sample acceptance policy requirements will be appropriately qualified.

Note 1: Temperature will be read and recorded based on the precision of the measuring device. For example, temperatures obtained from a thermometer graduated to 0.1°C will be read and recorded to ±0.1°C. Measurements obtained from a thermometer graduate to 0.5°C will be read to ±0.5°C. Measurements read at the specified precision are not to be rounded down to meet the ≤6°C limit

Note 2: Some microbiology methods allow sample receipt temperatures of up to 10°C. Consult the specific method for microbiology samples received above 6°C prior to initiating corrective action for out of temperature preservation conditions.

Note 3: Biological Tissue Samples must be received frozen at $\leq 0^{o}$C.

Upon sample receipt, the following items are also checked and recorded:

- Presence of custody seals or tapes on the shipping containers
- Sample condition: Intact, broken/leaking, bubbles in VOA samples
- Sample holding time
- Sample pH when required
- Appropriate containers

Samples for drinking water analysis that are improperly preserved, or are received past holding time, are rejected at the time of receipt, with the exception of VOA samples that are tested for pH at the time of analysis.

Additional information can be found in S-MN-C-001 ***Sample Management*** or its equivalent revision or replacement.

2.6. Sample Log-in

After sample inspection, all sample information on the chain of custody is entered into the Laboratory Information Management System.

This permanent record documents receipt of all sample containers including:

- Customer name and contact
- Customer number
- Pace Analytical project number
- Pace Analytical Project Manager
- Sample descriptions
- Due dates
- List of analyses requested
- Date and time of laboratory receipt
- Field ID code
- Date and time of collection
- Any comments resulting from inspection for sample rejection

All samples received are logged into the LIMS within one working day of receipt. Sample login may be delayed due to customer clarification of analysis needed, corrective actions for sample receipt non-conformance, or other unusual circumstances. If the time collected for any sample is unspecified and Pace is unable to obtain this information from the customer, the laboratory will use *00:00* as the time sampled. All hold times will be based on this sampling time and qualified accordingly if exceeded.

For DoD work, if the time of the sample collection is not provided, the laboratory must assume the most conservative time of day. This is defined as 12:01am.

The Laboratory Information Management System (EPIC Pro) automatically generates a unique identification number for each sample created in the system. The LIMS sample number follows the general convention of BB-XXXXXX-YYY. The BB represents the laboratory identification within Pace's laboratory network. The 5 digit "X" number represents the project number followed by a 3 digit sample number. The project number is a sequential number that is assigned as a new project is created. The sample number corresponds to the number of samples submitted by the client. In addition to the unique sample ID, there is a sample container ID that consists of the sample number, the container type (e.g. BP1U), and bottle 1 of Y, where Y represents the total number of containers of that particular type. Together the sample LIMs number and sample container ID number create a unique barcode encryption that can be linked to the sample analysis requested by the client. This unique identification number is placed on the sample container as a durable label and becomes the link between the laboratory's sample management system and the customer's field identification; it will be a permanent reference number for all future interactions.

Current region codes are noted below. More may be added without updating this document.

10 = Minnesota and Montana
92 = Asheville and Charlotte
60 = Kansas
50 = Indianapolis
3038 = Pittsburgh Radiological
25 = Seattle
51 = Columbus
35 = Florida
20 = Gulf Coast
30 = Pittsburgh
40 = Green Bay
17 = Pace Life Sciences
65 = Schenectady (NEA)

Sample labels are printed from the LIMS and affixed to each sample container.

Samples with hold times that are near expiration date/time may be sent directly to the laboratory for analysis at the discretion of the Project Manager and/or General Manager.

Additional information can be found in S-MN-C-001 ***Sample Management*** or its equivalent revision or replacement.

2.7. Sample Storage

2.7.1. Storage Conditions

Samples are stored away from all standards, reagents, or other potential sources of contamination. Samples are stored in a manner that prevents cross contamination. Volatile samples are stored separately from other samples. All sample fractions, extracts, leachates, and other sample preparation products are stored in the same manner as actual samples or as specified by the analytical method.

Storage blanks, consisting of two 40mL aliquots of reagent water, are stored with volatile samples and are used to measure cross-contamination acquired during storage. If applicable, laboratories

must have documented procedures and criteria for evaluating storage blanks, appropriate to the types of samples being stored.

2.7.2. Temperature Monitoring

Samples are taken to the appropriate storage location immediately after sample receipt and check-in procedures are completed. All sample storage areas are located in limited access areas and are monitored to ensure sample integrity.

The temperature of each refrigerated storage area is maintained at ≤6°C unless state or program requirements differ. The temperature of each freezer storage area is maintained at < - 10°C unless state or program requirements differ. The temperature of each storage area is checked and documented each day of use (each calendar day). If the temperature falls outside the acceptable limits, the following corrective actions are taken and appropriately documented:

- The temperature is rechecked after two hours to verify temperature exceedance. Corrective action is initiated if necessary.
- The Quality Manager and/or laboratory management are notified if the problem persists.
- The samples are relocated to a proper environment if the temperature cannot be maintained after corrective actions are implemented.
- The affected customers are notified.
- Documentation is provided on analytical report.

2.7.3. Hazardous Materials

Pure product or potentially heavily contaminated samples must be tagged as "hazardous" or "lab pack" and stored separately from other samples.

2.7.4. Foreign/Quarantined Soils

Depending on the soil disposal practices of the laboratory, foreign soils and soils from USDA regulated areas are segregated. The USDA requires these samples to be incinerated or sterilized by an approved treatment procedure. Additional information regarding USDA regulations and sample handling can be found in applicable local laboratory SOPs.

Additional information on sample storage can be found in S-MN-C-001 ***Sample Management***, in S-MN-Q-253 Procedure for Handling of USDA Regulated Soils, and in S-MN-S-003 ***Waste Handling and Management***, or equivalent replacement SOPs.

2.8. Sample Protection

PASI laboratory facilities are operated under controlled access protocols to ensure sample and data integrity. Visitors must register at the front desk and be properly escorted at all times.

Samples are removed from storage areas by designated personnel and returned to the storage areas, if necessary, immediately after the required sample quantity has been taken.

Upon customer request, additional and more rigorous chain of custody protocols for samples and data can be implemented. For example, some projects may require complete documentation of sample custody within the secure laboratory.

Additional information can be found in S-MN-C-001 ***Sample Management*** or its equivalent revision or replacement.

2.9. Subcontracting Analytical Services

Every effort is made to perform all analyses for PASI customers within the laboratory that receives the samples. When subcontracting to a laboratory other than the receiving laboratory, whether inside or outside the PASI network, becomes necessary, a preliminary verbal communication with that laboratory is undertaken. Customers are notified in writing of the subcontracting laboratory's intention to subcontract any portion of the testing to another laboratory. Work performed under specific protocols may involve special considerations.

Prior to subcontracting samples to a laboratory outside Pace Analytical, the potential sub-contract laboratory will be pre-qualified by verifying that the subcontractor meets the following criteria:

- All certifications required for the proposed subcontract are in effect,
- Sufficient professional liability and other required insurance coverage is in effect, and
- Is not involved in legal action by any federal, state, or local government agency for data integrity issues and has not been convicted in such investigation at any time during the past 5 years.

The contact and preliminary arrangements are made between the PASI Project Manager and the appropriate subcontract laboratory personnel. The specific terms of the subcontract laboratory agreement include:

- Method of analysis
- Number and type of samples expected
- Project specific QA/QC requirements
- Deliverables required
- Laboratory certification requirement
- Price per analysis
- Turn-around time requirements

Chain of custody forms are generated for samples requiring subcontracting to other laboratories. Sample receiving personnel re-package the samples for shipment, create a transfer chain of custody form and record the following information:

- Pace Analytical Laboratory Number
- Matrix
- Requested analysis
- Special instructions regarding turnaround, required detection or reporting limits, or any unusual information known about the samples or analytical procedure.
- Signature in "Relinquished By"

All subcontracted sample data reports are sent to the PASI Project Manager. Pace will provide a copy of the subcontractor's report to the client when requested.

Any Pace Analytical work sent to other labs within the PASI network is handled as subcontracted work and all final reports are labeled clearly with the name of the laboratory performing the work. Any non-NELAC work is clearly identified. PASI will not be responsible for analytical data if the subcontract laboratory was designated by the customer.

Additional information can be found in S-MN-C-004 ***Subcontracting Samples*** or its equivalent revision or replacement.

DoD laboratories must ensure that subcontracted labs meet the requirements of the DoD QSM. Subcontracted labs must be accredited by DoD or its designated representatives. Subcontracted labs must receive project specific approval from the DoD client before any samples are analyzed. These requirements also apply to the use of any laboratory under the same corporate umbrella, but at a different facility or location.

2.10. Sample Retention and Disposal

Samples, extracts, digestates, and leachates must be retained by the laboratory for the period of time necessary to protect the interests of the laboratory and the customer.

Unused portions of samples are retained by each laboratory based on program or customer requirements for sample retention and storage. The sample retention time is a minimum of 45 days from receipt of the samples. Samples requiring storage beyond this time due to special requests or contractual obligations will not be stored under temperature controlled conditions unless the laboratory has sufficient capacity and their presence does not compromise the integrity of other samples.

After this period expires, non-hazardous samples are properly disposed of as non-hazardous waste. The preferred method for disposition of hazardous samples is to return the excess sample to the customer. If it is not feasible to return samples, or the customer requires PASI to dispose of excess samples, proper arrangements will be made for disposal by an approved contractor.

Additional information can be found in S-MN-S-003 ***Waste Handling and Management*** and S-MN-C-001 ***Sample Management*** or their equivalent revisions or replacements.

3.0. ANALYTICAL CAPABILITIES

3.1. Analytical Method Sources

PASI laboratories are capable of analyzing a full range of environmental samples from a variety of matrices, including air, surface water, wastewater, groundwater, soil, sediment, biota, and other waste products. The latest valid editions of methodologies are applied from regulatory and professional sources including EPA, ASTM, USGS, NIOSH, A2LA, A-Class, NVLAP, Standard Methods, and State Agencies. Section 11 is a representative listing of general analytical protocol references. PASI discloses in writing to its customers and regulatory agencies any instances in which modified methods are being used in the analysis of samples.

In the event of a customer-specific need, instrumentation constraint or regulatory requirement, PASI laboratories reserve the right to use valid versions of methods that may not be the most recent edition available.

3.2. Analytical Method Documentation

The primary form of PASI laboratory documentation of analytical methods is the Standard Operating Procedure (SOP). SOPs contain pertinent information as to what steps are required by an analyst to successfully perform a procedure. The required contents for the SOPs are specified in the company-wide SOP for ***Preparation of SOPs***, S-ALL-Q-001, or equivalent replacement.

The SOPs may be supplemented by other training materials that further detail how methods are specifically performed. This training material will undergo periodic, documented review along with the other Quality System documentation.

3.3. Analytical Method Validation

In some situations, PASI develops and validates methodologies that may be more applicable to a specific problem or objective. When non-standard methods are required for specific projects or analytes of interest, or when the laboratory develops or modifies a method, the laboratory validates the method prior to applying it to customer samples. Method validity is established by meeting criteria for precision and accuracy as established by the data quality objectives specified by the end user of the data. The laboratory records the validation procedure, the results obtained and a statement as to the usability of the method. The minimum requirements for method validation include determination of the limit of detection and limit of quantitation, evaluation of precision and bias, and evaluation of selectivity of each analyte of interest.

Additional information can be found in SOP S-MN-Q-252 ***Methods Validation and Modification Studies***, or equivalent replacement.

3.4. Demonstration of Capability (DOC)

Analysts complete an initial demonstration of capability (IDOC) study prior to performing a method or when there is a change in instrument type, personnel, or test method, or at any time that a method has not been performed by the laboratory or analyst in a 12-month period. The mean recovery and

standard deviation of each analyte, taken from 4 replicates of a quality control standard is calculated and compared to method criteria (if available) or established laboratory criteria for evaluation of acceptance. Each laboratory maintains copies of all demonstrations of capability, including those that fail acceptance criteria and corresponding raw data for future reference and must document the acceptance criteria prior to the analysis of the DOC. Demonstrations of capability are verified on an annual basis.

For Continuing Demonstrations of Capability, the laboratories may use Performance Testing (PT) samples in lieu of the 4-replicate approach listed above. For methods or procedures that do not lend themselves to the "4-replicate" approach, the demonstration of capability requirements will be specified in Section 13 – Method Performance of the applicable SOP.

Alternative demonstrations of capability procedures may be used for methods that don't lend themselves to the "4 replicate" approach. For methods that only measure precision, the precision of four laboratory duplicate pairs will be assessed. The relative percent differences must be within the method acceptance limits. For procedures like TCLP or SPLP, the analyst will demonstrate making the buffer solution and performing the tumbling process. The trainer or supervisor will sign-off on demonstration of capability of the tumbling process.

Additional information can be found in SOP S-ALL-Q-020 ***Training Procedures*** or its equivalent revision or replacement.

3.5. Regulatory and Method Compliance

PASI understands that expectations of our customers commonly include the assumption that laboratory data will satisfy specific regulatory requirements. Therefore PASI attempts to ascertain, prior to beginning a project, what applicable regulatory jurisdiction, agency, or protocols apply to that project. This information is also required on the chain of custody submitted with samples.

PASI makes every effort to detect regulatory or project plan inconsistencies, based upon information from the customer, and communicate them immediately to the customer in order to aid in the decision making process. PASI will not be liable if the customer chooses not to follow PASI recommendations.

It is PASI policy to disclose in a forthright manner any detected noncompliance affecting the usability of data produced by our laboratories. The laboratory will notify customers within 30 days of fully characterizing the nature of the nonconformance, the scope of the nonconformance and the impact it may have on data usability.

4.0. QUALITY CONTROL PROCEDURES

Quality control data is analyzed and where they are found to be outside pre-defined criteria, planned action is taken to correct the problem in order to prevent incorrect results from being reported. Quality control samples are to be processed in the same manner as client samples.

4.1. Method Blank

A method blank is used to evaluate contamination in the preparation/analysis system and is processed through all preparation and analytical steps with its associated samples.

A method blank is processed at a minimum frequency of one per preparation batch. In the case of a method that has no separate preparation step, a method blank is processed with no more than 20 samples of a specific matrix performed by the same analyst, using the same method, standards, and reagents.

The method blank consists of a matrix similar to the associated samples that is known to be free of analytes of interest. Laboratories will characterize a representative matrix as "clean" if the matrix contains contaminants at less than ½ the laboratory's reporting limit.

Method blanks are not applicable for certain analyses, such as pH, conductivity, flash point and temperature.

Each method blank is evaluated for contamination. The source of any contamination is investigated and documented corrective action is taken when the concentration of any target analyte is detected above the reporting limit and is greater then 1/10 of the amount of that analyte found in any associated sample. Corrective actions include the re-preparation and re-analysis of all the samples (where possible) along with the full set of required quality control samples. Data qualifiers must be applied to any result reported that is associated with a contaminated method blank.

For DoD samples, the method blank will be considered to be contaminated if: 1) The concentration of any target analyte in the method blank exceeds 1/2 the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit whichever is greater; 2) The concentration of any common laboratory contaminant in the method blank exceeds the reporting limit and is greater than 1/10 the amount measured in any sample or 1/10 the regulatory limit whichever is greater or 3) The method blank result otherwise affects the sample results as per the test method requirements or the project-specific objectives. If the method blank is contaminated as described above, then the laboratory shall reprocess affected samples in a subsequent preparation batch, except when sample results are below the LOD. If insufficient sample volume remains for reprocessing, the results shall be reported with appropriate data qualifiers.

Deviations made from this policy must be approved by the Quality Manager prior to release of the data.

For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of method blank having any reportable contamination, the laboratory is required to reanalyze the associated samples with an acceptable method blank if there is sufficient sample remaining. Acceptable method blanks are those that are free of contamination below the reporting limit. The

laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding method blanks for Ohio VAP projects.

4.2. Laboratory Control Sample

The Laboratory Control Sample (LCS) is used to evaluate the performance of the entire analytical system including preparation and analysis.

An LCS is processed at a minimum frequency of one per preparation batch. In the case of a method that has no separate preparation step, an LCS will be processed with no more than 20 samples of a specific matrix performed by the same analyst, using the same method, standards, and reagents.

The LCS consists of a matrix similar to the associated samples that is known to be free of the analytes of interest that is then spiked with known concentrations of target analytes.

The LCS contains **all** analytes specified by a specific method or by the customer or regulatory agency (which may include full list of target compounds, with certain exceptions. These exceptions may include analyzing only specific Aroclors when PCB analysis is requested or not spiking with all EPA Appendix IX compounds when a full Appendix IX list of compounds is requested). In the absence of specified components, the laboratory will spike with the following compounds:

- For multi-peak analytes (e.g. PCBs, technical chlordane, toxaphene), a representative standard will be processed.
- For methods with long lists of analytes, a representative number of target analytes may be chosen. The following criteria is used to determine the number of LCS compounds used:
  - For methods with 1-10 target compounds, the laboratory will spike with all compounds
  - For methods with 11-20 target compounds, the laboratory will spike with at least 10 compounds or 80%, whichever is greater
  - For methods with greater than 20 compounds, the laboratory will spike with at least 16 compounds.

The LCS is evaluated against the method default or laboratory-derived acceptance criteria. For those methods that require laboratory-derived limits, method default control limits may be used until the laboratory has a minimum of 20, but preferably greater than 30, data points from which to derive internal acceptance criteria. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Any associated sample containing an 'out-of-control' compound must either be re-analyzed with a successful LCS or reported with the appropriate data qualifier. When the acceptance criteria for the LCS are exceeded high, and there are associated samples that are non-detects, then those non-detects can be reported with data qualifiers, or when the acceptance criteria are exceeded low, those associated sample results may be reported if they exceed the maximum regulatory limit/decision level with data qualifiers.

For LCSs containing a large number of analytes, it is statistically likely that a few recoveries will be outside of control limits. This does not necessarily mean that the system is out of control, and therefore no corrective action would be necessary (except for proper documentation). NELAC has allowed for a minimum number of marginal exceedances, defined as recoveries that are beyond the LCS control limits (3X the standard deviation) but less than the marginal exceedance limits (4X the standard deviation). The number of allowable exceedances depends on the number of compounds in

the LCS. If more analyte recoveries exceed the LCS control limits than is allowed (see below) or if any one analyte exceeds the marginal exceedance limits, then the LCS is considered non-compliant and corrective actions are necessary. The number of allowable exceedances is as follows:

- >90 analytes in the LCS- 5 analytes
- 71-90 analytes in the LCS- 4 analytes
- 51-70 analytes in the LCS- 3 analytes
- 31-50 analytes in the LCS- 2 analytes
- 11-30 analytes in the LCS- 1 analyte
- <11 analytes in the LCS- no analytes allowed out)

A matrix spike (MS) can be used in place of a non-compliant LCS in a batch as long as the MS passes the LCS acceptance criteria (this is a NELAC allowance). When this happens, full documentation must be made available to the data user. If this is not allowed by a customer or regulatory body, the associated samples must be rerun with a compliant LCS (if possible) or reported with appropriate data qualifiers.

Deviations made from this policy must be approved by the Quality Manager prior to release of the data.

For Ohio VAP and South Carolina projects, the laboratory must minimize the use of qualified data. In the case of LCS failures, the laboratory is required to reanalyze the associated samples with an acceptable LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Ohio VAP projects.

For Department of Defense projects, the laboratory is not allowed to have any target analytes that exceed DoD LCS control limits. In the case of LCS failures, the laboratory is required to reanalyze the associated samples with an acceptable LCS for all target compounds if there is sufficient sample remaining. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Department of Defense projects. See applicable method SOPs for further corrective action.

4.3. Matrix Spike/Matrix Spike Duplicate (MS/MSD)

A matrix spike (MS) is used to determine the effect of the sample matrix on compound recovery for a particular method. The information from these spikes is sample or matrix specific and is not used to determine the acceptance of an entire batch unless the MS is actually used as the LCS.

A **Matrix Spike/Matrix Spike Duplicate** (MS/MSD) set is processed at a frequency specified in a particular method or as determined by a specific customer request. This frequency will be specified in the applicable method SOP or customer QAPP. In the absence of such requirements, an MS/MSD set is routinely analyzed once per every 20 samples per matrix per method.

The MS and MSD consist of the sample matrix that is then spiked with known concentrations of target analytes. Laboratory personnel spike customer samples that are specifically designated as MS/MSD samples or, when no designated samples are present in a batch, randomly select samples to

spike that have adequate sample volume or weight. Spiked samples are prepared and analyzed in the same manner as the original samples and are selected from different customers if possible.

The MS and MSD contain all analytes specified by a specific method or by the customer or regulatory agency. In the absence of specified components, the laboratory will spike with the same number of compounds as previously discussed in the LCS section.

The MS and MSD are evaluated against the method or laboratory derived criteria. Any compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Batch acceptance, however, is based on method blank and LCS performance, not on MS/MSD recoveries. The spike recoveries give the data user a better understanding of the final results based on their site specific information.

A matrix spike and sample duplicate will be performed instead of a matrix spike and matrix spike duplicate when specified by the customer or method.

Deviations made from this policy must be approved by the Quality Manager prior to release of the data.

For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of MS/MSD failures, the laboratory is required to reanalyze the associated samples only when the associated LCS also fails acceptance criteria and if there is sufficient sample remaining. When an LCS is acceptable and the MS results are outside of criteria, and no system anomaly is detected, the samples will be reported with appropriate data qualifiers indicating matrix interference. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding LCSs for Ohio VAP projects.

For DoD work, each preparation batch of samples must contain an associated MS and MSD (or sample duplicate) using the same matrix collected for the specific DoD project. If adequate sample material is not available, then the lack of MS/MSDs shall be noted in the case narrative. Additional MS/MSDs may be required on a project-specific basis. The MS/MSD must be spiked with all target analytes with the exception of PCB analysis, which is spiked per the method. The concentration of the spiked compounds shall be at or below the midpoint of the calibration range or at the appropriate concentration of concern. Multiple spiked samples may need to be prepared to avoid interferences.

For DoD work, the results of all MS/MSD must be evaluated using the same acceptance criteria used for the LCS.

4.4. Surrogates

Surrogates are compounds that reflect the chemistry of target analytes and are typically added to samples for organic analyses to monitor the effect of the sample matrix on compound recovery.

Surrogates are added to each customer sample (for organics), method blank, LCS, and MS prior to extraction or analysis. The surrogates are evaluated against the method or laboratory derived acceptance criteria or against project-specific acceptance criteria specified by the client, if applicable. Any surrogate compound that is outside of these limits is considered to be 'out of control' and must be qualified appropriately. Samples with surrogate failures are typically re-

extracted and/or re-analyzed to confirm that the out-of-control value was caused by the matrix of the sample and not by some other systematic error. An exception to this would be samples that have high surrogate values but no reportable hits for target compounds. These samples would be reported, with a qualifier, because the implied high bias would not affect the final results. For methods with multiple surrogates, documentation regarding acceptance and associated compounds will be found in the individual method SOPs.

Deviations made from this policy must be approved by the Quality Manager prior to release of the data.

4.5. Sample Duplicate

A sample duplicate is a second portion of sample that is prepared and analyzed in the laboratory along with the first portion. It is used to measure the precision associated with preparation and analysis. A sample duplicate is processed at a frequency specified by the particular method or as determined by a specific customer.

The sample and duplicate are evaluated against the method or laboratory derived criteria for relative percent difference (RPD). Any duplicate that is outside of these limits is considered to be 'out of control' and must be qualified appropriately.

Deviations made from this policy must be approved by the Quality Manager prior to release of the data.

For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of duplicate samples exceeding the RPD criteria found in applicable analytical SOPs, the laboratory is required to reanalyze the associated sample and duplicate as long as no sampling error was detected if there is sufficient sample remaining. If the sample and duplicate still do not agree, a comment would be made stating there may be sample non-homogeneity. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding sample duplicates for Ohio VAP projects.

4.6. Internal Standards

Internal Standards are method-specific analytes added to every standard, method blank, laboratory control sample, matrix spike, matrix spike duplicate, and sample at a known concentration, prior to analysis for the purpose of adjusting the response factor used in quantifying target analytes. At a minimum, the laboratory will follow method specific guidelines for the treatment of internal standard recoveries as they are related to the reporting of data.

Deviations made from this policy must be approved by the Quality Manager prior to release of the data.

For Ohio VAP projects, samples with internal standard that are outside of method criteria must be reanalyzed to confirm sample matrix effect. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding internal standards for Ohio VAP projects.

4.7. Field Blanks

Field blanks are blanks prepared at the sampling site in order to monitor for contamination that may be present in the environment where samples are collected. These field quality control samples are often referenced as field blanks, rinsate blanks, or equipment blanks. The laboratory analyzes these field blanks as normal samples and informs the customer if there are any target compounds detected above the reporting limits.

4.8. Trip Blanks

Trip blanks are blanks that originate from the laboratory as part of the sampling event and are used to monitor for contamination of samples during transport. These blanks accompany the empty sample containers to the field and then accompany the collected samples back to the laboratory. These blanks are routinely analyzed for volatile methods where ambient background contamination is likely to occur.

4.9. Limit of Detection (LOD)

PASI laboratories are required to use a documented procedure to determine a limit of detection for each analyte of concern in each matrix reported. All sample processing steps of the preparation and analytical methods are included in this determination including any clean ups. For any test that does not have a valid LOD, sample results below the limit of quantitation (LOQ) cannot be reported.

The LOD is initially established for the compounds of interest for each method in a clean matrix with no target analytes present and no interferences at a concentration that would impact the results. The LOD is then determined every time there is a change in the test method that affects how the test is performed or when there has been a change in the instrument that affects the sensitivity. If required by customer, method or accreditation body, the LOD will be re-established annually for all applicable methods.

Unless otherwise noted, the method used by PASI laboratories to determine LODs is based on the Method Detection Limit (MDL) procedure outlined in 40 CFR Part 136, Appendix B. Where required by regulatory program or customer, the above referenced procedure will be followed.

Where specifically stated in the published method, LODs or MDLs will be performed at the listed frequency.

The validity of the LOD must be shown by detection (a value above zero) of the analytes in a QC sample in each quality system matrix. The QC sample must contain the analyte at no more than 3X the LOD for a single analyte test and 4X the LOD for multiple analyte tests. This verification must be performed on each instrument used for sample analysis and reporting of data. The validity of the LOD must be verified as part of the LOD determination process. This verification must be done prior to the use of the LOD for sample analysis.

An LOD study is not required for any analyte for which spiking solutions or quality control samples are not available such as temperature.

The LOD, if required, shall be verified annually for each quality system matrix, technology and analyte. In lieu of performing full LOD (MDL) studies annually, the laboratory can verify the LOD (MDL) on an annual basis, providing this verification is fully documented and does not contradict other customer or program requirements that the laboratory must follow. The requirements of this verification are:

- The spike concentration of the verification must be no more than 3X times the LOD for single analyte tests and 4X the LOD for multiple analyte tests.
- The laboratory must verify the LOD on each instrument used for the reporting of sample data.
- The laboratory must be able to identify all target analytes in the verification standard (distinguishable from noise).

For Ohio VAP projects, a valid MDL must be in place prior to sample analysis. MDLs must be spiked at or below the reporting limit and will not be accepted if it was spike higher than the reporting limit.

Additional information can be found in SOP S-MN-Q-269 ***Method Detection Limit Studies*** or its equivalent revision or replacement.

4.10. Limit of Quantitation (LOQ)

A limit of quantitation (LOQ) for every analyte of concern must be determined. For PASI laboratories, this LOQ is referred to as the RL, or Reporting Limit. This RL is based on the lowest calibration standard concentration that is used in each initial calibration. Results below this level are not allowed to be reported without qualification since the results would not be substantiated by a calibration standard. For methods with a determined LOD, results can be reported out below the LOQ but above the LOD if they are properly qualified (e.g. J flag).

The LOQ must be higher than the LOD.

To verify the LOQ, the laboratory will prepare a sample in the same matrix used for the LCS. The sample will be spiked with target analytes at the concentration(s) equivalent to or less than the RL(s). This sample must undergo the routine sample preparation procedure including any routine sample cleanup steps. The sample is then analyzed and the recovery of each target analyte determined. The recovery for each target analyte must meet the laboratories current control limits for an LCS.

For DoD approved methods, the LOQ and LOD shall be verified quarterly and valid LOQ must be in place prior to sample analysis.

Additional information can be found in SOP S-MN-Q-269 ***Method Detection Limit Studies*** or its equivalent revision or replacement.

4.11. Estimate of Analytical Uncertainty

PASI laboratories can provide an estimation of uncertainty for results generated by the laboratory. The estimate quantifies the error associated with any given result at a 95% confidence interval. This

estimate does not include bias that may be associated with sampling. The laboratory has a procedure in place for making this estimation. In the absence of a regulatory or customer-specific procedure, PASI laboratories base this estimation on the recovery data obtained from the Laboratory Control Spikes. The uncertainty is a function of the standard deviation of the recoveries multiplied by the appropriate Student's t Factor at 95% confidence. Additional information pertaining to the estimation of uncertainty and the exact manner in which it is derived are contained in the SOP *S-MN-Q-255, **Estimation of Uncertainty*** or its equivalent revision or replacement.

The measurement of uncertainty is provided only on request by the customer, as required by specification or regulation and when the result is used to determine conformance within a specification limit.

4.12. Proficiency Testing (PT) Studies

PASI laboratories participate in the NELAC defined proficiency testing program. PT samples are obtained from NIST approved providers and analyzed and reported at a minimum of two times per year for the relevant fields of testing per matrix.

The laboratory initiates an investigation whenever PT results are deemed 'unacceptable' by the PT provider. All findings and corrective actions taken are reported to the Quality Manager. A corrective action plan is initiated and this report is sent to the appropriate state accreditation agencies for their review. Additional PTs will be analyzed and reported as needed for certification purposes.

PT samples are treated as typical customer samples, utilizing the same staff, methods, equipment, facilities, and frequency of analysis. PT samples are included in the laboratory's normal analytical processes and do not receive extraordinary attention due to their nature.

Comparison of analytical results with anyone participating in the same PT study is prohibited prior to the close of the study.

Additional information can be found in SOP S-MN-Q-258 ***PE/PT Program*** or its equivalent revision or replacement.

4.13. Rounding and Significant Figures

In general, the PASI laboratories report data to no more than three significant digits. Therefore, all measurements made in the analytical process must reflect this level of precision. In the event that a parameter that contributes to the final result has less than three significant figures of precision, the final result must be reported with no more significant figures than that of the parameter in question. The rounding rules listed below are descriptive of the LIMS and not necessarily of any supporting program such as Excel.

4.13.1. Rounding

PASI-Minnesota and Montana follows the odd / even guidelines for rounding numbers:

- If the figure following the one to be retained is less than five, that figure is dropped and the retained ones are not changed (with three significant figures, 2.544 is rounded to 2.54).

- If the figure following the ones to be retained is greater than five, that figure is dropped and the last retained one is rounded up (with three significant figures, 2.546 is rounded to 2.55).
- If the figure following the ones to be retained is five and if there are no figures other than zeros beyond that five, then the five is dropped and the last figure retained is unchanged if it is even and rounded up if it is odd (with three significant figures, 2.525 is rounded to 2.52 and 2.535 is rounded to 2.54).

4.13.2. Significant Digits

Unless specified by federal, state, or local requirements or on specific request by a customer, PASI-Minnesota and Montana reports all analytical results to 3 significant digits, regardless of the magnitude of the value reported.

PASI-Minnesota and Montana follows the following convention for reporting to a specified number of significant figures. Unless specified by federal, state, or local requirements or on specific request by a customer, the laboratory reports:

- Values > 10 – Reported to 3 significant digits
- Values ≤ 10 – Reported to 2 significant digits

5.0. DOCUMENT MANAGEMENT AND CHANGE CONTROL

5.1. Document Management

Additional information can be found in SOP S-ALL-Q-002 ***Document Management*** or its equivalent revision or replacement. Information on Pace's policy for electronic signatures can also be found in this SOP.

Pace Analytical Services, Inc. has an established procedure for managing documents that are part of the quality system. The list of managed documents includes, but is not limited to, Standard Operating Procedures (both technical and non-technical), Quality Assurance Manuals, quality policy statements, training documents, work-processing documents, charts, posters, memoranda, notices, forms, software, and any other procedures, tables, plans, etc. that have a direct bearing on the quality system (including applicable data records and non-technical documents).

A master list of all managed documents is maintained at each facility identifying the current revision status and distribution of the controlled documents. This establishes that there are no invalid or obsolete documents in use in the facility. All documents are reviewed periodically and revised if necessary. Obsolete documents are systematically discarded or archived for audit or knowledge preservation purposes.

Each managed document is uniquely identified to include the date of issue, the revision identification, page numbers, the total number of pages and the issuing authorities. For complete information on document numbering, refer to SOP S-ALL-Q-003 ***Document Numbering***.

SOPs, specifically, are available to all laboratory staff via the Learning Management System (LMS) which is a secure repository that is accessed through an internet portal. As a local alternative to the hard copy system of controlled documents, secured electronic copies of controlled documents may be maintained on the laboratory's local server. These document files must be read-only for all personnel except the Quality Department and system administrator. Other requirements for this system are as follows:

- Electronic documents must be readily accessible to all facility employees.
- All hardcopy SOPs must be obtained from the Quality Department.

5.1.1. Quality Assurance Manual (QAM)

The Quality Assurance Manual is the company-wide document that describes all aspects of the quality system for PASI. The base QAM template is distributed by the Corporate Quality Department to each of the regional Quality Managers. The regional management personnel modify the necessary and permissible sections of the base template and submit those modifications to the Corporate Director of Quality for review. Once approved and signed by both the CEO and the Director of Quality; the General Manager, Quality Manager, and any Technical Directors, however named, sign the Quality Assurance Manual. Each regional Quality Manager is then in charge of distribution to employees, external customers or regulatory agencies and maintaining a distribution list of controlled document copies. The Quality Assurance Manual template is reviewed on an annual basis by all of the PASI Quality Managers and revised accordingly by the Director of Quality.

5.1.2. Standard Operating Procedures (SOPs)

SOPs fall into two categories: company-wide documents and facility specific documents. Company-wide SOPs start with the prefix S-ALL- and local SOPs start with the individual facility prefix.

The purpose of the company-wide SOPs is to establish policies and procedure that are common and applicable to all PASI facilities. Company-wide SOPs are document-controlled by the corporate quality office and signed copies are distributed to all of the laboratory Quality Managers. The laboratory management personnel sign the company-wide SOPs. The laboratory Quality Manager is then in charge of distribution to employees, external customers, or regulatory agencies and maintaining a distribution list of controlled document copies.

PASI facilities are responsible for developing facility-specific SOPs applicable to their respective facility. The laboratory develops these facility-specific SOPs based on the corporate-wide SOP template. This template is written to incorporate a set of minimum method requirements and PASI best practice requirements. The laboratory facilities may add to or modify the corporate-wide SOP template provided there are no contradictions to the minimum method or best practice requirements. Facility-specific SOPs are controlled by the laboratory Quality Manager according to the corporate document management policies.

SOPs are reviewed every two years at a minimum although a more frequent review may be required by some state or federal agencies or customers. A review of the document does not necessarily constitute issuing a new revision. Documentation of this review and any applicable revisions are made in the last section of each SOP. This provides a historical record of all revisions.

All copies of superseded SOPs are removed from general use and the original copy of each SOP is archived for audit or knowledge preservation purposes. This ensures that all PASI employees use the most current version of each SOP and provides the Quality Manager with a historical record of each SOP.

Additional information can be found in SOP S-ALL-Q-001 ***Preparation of SOPs*** or its equivalent revision or replacement.

For Ohio VAP certification, it is required by the Ohio Administrative Code that the laboratory must seek Ohio VAP review and approval of all SOPs and Quality Manual subsequent modifications prior to implementation.

For DoD approval, all technical SOPs are reviewed for accuracy and adequacy annually and whenever method procedures change and updated as appropriate. All such reviews are documented and made available for assessment. Non-technical SOPs that are not required elements of the quality system are considered administrative SOPs and are not required to be reviewed annually.

5.1.3. Other Documentation

Additional documents such as Forms and Spreadsheets are controlled through the document management system.

5.2. Document Change Control

Changes to managed documents are reviewed and approved in the same manner as the original review. Any revision to a document requires the approval of the applicable signatories. After revisions are approved, a revision number is assigned and the previous version of the document is officially retired. Copies may be kept for audit or knowledge preservation purposes.

All controlled copies of the previous document are replaced with controlled copies of the revised document and the superseded copies are destroyed or archived. All affected personnel are advised that there has been a revision and any necessary training is scheduled.

5.3. Management of Change

The process for documenting necessary changes within the laboratory network are not typically handled using the corrective or preventive action system as outlined in section 9.0. Management of Change is a proactive approach to dealing with change to minimize the potential negative impact of systematic change in the laboratory and to ensure that each change has a positive desired outcome. This process will primarily be used for the implementation of large scale projects and information system changes as a means to apply consistent systems or procedures within the laboratory network. The request for change is submitted by the initiator and subsequently assigned to an individual or team for development and planning. The final completion of the process culminates in final approval and verification that the procedure was effectively implemented. Additional information can be found in SOP S-MN-Q-257 ***Management of Change*** or its equivalent revision or replacement.

6.0. EQUIPMENT AND MEASUREMENT TRACEABILITY

Each PASI facility is equipped with sufficient instrumentation and support equipment to perform the relevant analytical testing or field procedures performed by each facility. Support equipment includes chemical standards, thermometers, balances, disposable and mechanical pipettes, etc. This section details some of the procedures necessary to maintain traceability and to perform proper calibration of instrumentation and support equipment. See Attachment III for a list of equipment currently used at the Minnesota and Montana PASI facilities.

6.1. Standards and Traceability

Each PASI facility retains all pertinent information for standards, reagents, and chemicals to assure traceability to a national standard. This includes documentation of purchase, receipt, preparation, and use.

Upon receipt, all purchased standard reference materials are recorded into a standard logbook or database and assigned a unique identification number. The entries include the facility's unique identification number, the chemical name, manufacturer name, manufacturer's identification numbers, receipt date, and expiration date. Vendor's certificates of analysis for all standards, reagents, or chemicals are retained for future reference.

Subsequent preparations of intermediate or working solutions are also documented in a standard logbook or database. These entries include the stock standard name and lot number, the manufacturer name, the solvents used for preparation, the solvent lot number and manufacturer, the preparation steps, preparation date, expiration dates, preparer's initials, and a unique PASI identification number. This number is used in any applicable sample preparation or analysis logbook so the standard can be traced back to the standard preparation record. This process ensures traceability back to the national standard.

All prepared standard or reagent containers include the PASI identification number, the standard or chemical name, the date of preparation, the date of expiration, the concentration with units, and the preparer's initials. This ensures traceability back to the standard preparation logbook.

For containers that are too small to accommodate labels that list all of the above information associated with a standard, the minimum required information will be PASI standard ID, concentration, and expiration date. This assures that no standard will be used past its assigned expiration date.

If a second source standard is required to verify an existing calibration or spiking standard, this standard should be obtained from a different manufacturer or from a different lot unless client specific QAPP requirements state otherwise.

Additional information concerning standards and reagent traceability can be found in the SOP S-ALL-Q-025 ***Standard and Reagent Preparation and Traceability*** or its equivalent revision or replacement.

6.2. General Analytical Instrument Calibration Procedures

All support equipment and instrumentation are calibrated or checked before use to ensure proper functioning and verify that the laboratory's requirements are met. All calibrations are performed by, or under the supervision of, an experienced analyst at scheduled intervals against either certified standards traceable to recognized national standards or reference standards whose values have been statistically validated.

Calibration standards for each parameter are chosen to establish the linear range of the instrument and must bracket the concentrations of those parameters measured in the samples. The lowest calibration standard is the lowest concentration for which quantitative data may be reported. Data reported below this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in a narrative. The highest calibration standard is the highest concentration for which quantitative data may be reported. Data reported above this level is considered to have less certainty and must be reported using appropriate data qualifiers or explained in the narrative. Any specific method requirement for number and type of calibration standards supersedes the general requirement. Instrument and method specific calibration criteria are explained within the specific analytical standard operating procedures for each facility.

Instrumentation or support equipment that cannot be calibrated to specification or is otherwise defective is clearly labeled as out-of-service until it has been repaired and tested to demonstrate it meets the laboratory's specifications. All repair and maintenance activities including service calls are documented in the maintenance log. Equipment sent off-site for calibration testing is packed and transported to prevent breakage and is in accordance with the calibration laboratory's recommendations.

In the event that recalibration of a piece of test equipment indicates the equipment may have been malfunctioning during the course of sample analysis, an investigation is performed. The results of the investigation along with a summary of the information reviewed are documented and maintained by the quality manager. If the investigation indicates sample results have been impacted, the customer is notified within 30 days. This allows for sufficient investigation and review of documentation to determine the impact on the analytical results. Instrumentation found to be consistently out of calibration is either repaired and positively verified or taken out of service and replaced.

Raw data records are retained to document equipment performance. Sufficient raw data is retained to reconstruct the instrument calibration and explicitly connect the continuing calibration verification to the initial calibration.

6.2.1. General Organic Calibration Procedures

Calibration standards are prepared at a minimum of five concentrations for organic analyses. Results from all calibration standards analyzed must be included in constructing the calibration curve with the following exceptions:

- The lowest level calibration standard may be removed from the calibration as long as the remaining number of concentration levels meets the minimum established by the method and standard operating procedure. For multi-parameter methods, this may be done on an individual analyte basis. The reporting limit must be adjusted to the lowest concentration included in the calibration curve.

- The highest level calibration standard may be removed from the calibration as long as the remaining number of concentration levels meets the minimum established by the method and standard operating procedure. For multi-parameter methods, this may be done an individual analyte basis. The upper limit of quantitation must be adjusted to the highest concentration included in the calibration curve.
- Multiple points from either the high end or the low end of the calibration curve may be excluded as long as the remaining points are contiguous in nature and the minimum number of levels remains as established by method or standard operating procedure. The reporting limit or quantitation range, which is appropriate, must be adjusted accordingly.
- Results from a concentration level between the lowest and highest calibration levels can be excluded from the calibration curve for an acceptable cause with approval from the responsible department supervisor if the results for all analytes are excluded and the point is replaced by re-analysis. Re-analysis must occur within the same 12 hour tune time period for GC/MS methodologies and within 8 hours of the initial analysis for non-GC/MS methodologies, unless otherwise specified in the reference method. All samples analyzed prior to the re-analyzed calibration curve point must be re-analyzed after the calibration curve is completed.

Initial calibration curves are evaluated against appropriate statistical models as required by the analytical methods. Curves that do not meet the appropriate criteria require corrective action that may include re-running the initial calibration curve. All initial calibrations are verified with an initial calibration verification standard (ICV) obtained from a second manufacturer or second lot from the same manufacturer if that lot can be demonstrated as prepared independently from other lots prior to the analysis of samples. Sample results are quantitated from the initial calibration unless otherwise required by regulation, method, or program.

The calibration curve is periodically verified by the analysis of a mid-level continuing calibration verification (CCV) standard during the course of sample analysis. Continuing calibration verification is performed at the beginning and end of each analytical batch except if an internal standard is used, then only one verification at the beginning of the batch is needed, whenever it is expected that the analytical system may be out of calibration, if the time period for calibration has expired, or for analytical systems that have specific calibration verification requirements. This verification standard must meet acceptance criteria in order for sample analysis to proceed.

In the event that the CCV does not meet the acceptance criteria, a second CCV may be injected as part of the diagnostic evaluation and corrective action investigation. If the second CCV is acceptable, the analytical sequence may be continued. If both CCVs fail, the analytical sequence is terminated and corrective action is initiated. Sample analysis cannot begin until after documented corrective action has been completed and two consecutive passing CCVs have been analyzed. If required by specific state, program, or customer specification, the instrument is re-calibrated after two consecutive CCV failures. All samples analyzed since the last compliant CCV are re-analyzed for methodologies utilizing external calibration.

When instruments are operating unattended, autosamplers may be programmed to inject consecutive CCVs as a preventative measure against CCV failure with no corrective action. In this case, both CCVs must be evaluated to determine potential impact to the results. A summary of the decision tree and necessary documentation are listed below:

- If both CCVs meet the acceptance criteria, the analytical sequence is allowed to continue without corrective action. The 12 hour clock begins with the injection of the second CCV.
- If the first CCV does not meet the acceptance criteria and the second CCV is acceptable, the analytical sequence is continued and the results are reported.
- If the first CCV meets the acceptance criteria and the second CCV is out of control, the samples preceded by the out of control CCV must be re-analyzed in a compliant analytical sequence.
- If both CCVs are out of control, all samples since the last acceptable CCV must be re-analyzed in a compliant analytical sequence.

For DoD projects per Gray Box 37, if the laboratory analyzes two CCVs in a row as defined above, both CCVs must be evaluated. If either CCV fails, all samples and QC preceding and following the CCV pair have to be reanalyzed.

Some analytical methods require that samples be bracketed by passing CCVs analyzed both before and after the samples. This is specific to each method but, as a general rule, all external calibration methods require bracketing CCVs. Most internal standard calibrations do not require bracketing CCVs.

Some analytical methods require verification based on a time interval; some methods require a frequency based on an injection interval. The type and frequency of the calibration verifications is dependent on both the analytical method and possibly on the quality program associated with the samples. The type and frequency of calibration verification will be documented in the method specific SOP employed by each laboratory.

For Ohio VAP projects, the laboratory must minimize the use of qualified data. In the case of calibration verification standard failures, the laboratory is required to reanalyze the CCV and the associated samples so as not to report qualified data. Sample results may be reported if the CCV failure produces a high bias and the samples are non-detect. Where possible, the second attempt should be made using the original aliquot of the standard unless there is reason to suspect that the standard is the cause of failure. The laboratory must make every effort to take the appropriate corrective actions and resolve any anomalies regarding calibration verification standard failures for Ohio VAP projects.

6.2.2. General Inorganic Calibration Procedures

The instrument is initially calibrated with standards at multiple concentrations to establish the linearity of the instrument's response. A calibration blank is also included. Initial calibration curves are evaluated against appropriate statistical models as required by the analytical methods. The number of calibration standards used depends on the specific method criteria or customer project requirements, although normally a minimum of three standards is used.

The ICP and ICP/MS can be standardized with a zero point and a single point calibration if:

- Prior to analysis, the zero point and the single point calibration are analyzed and a linear range has been established,
- Zero point and single point calibration standards are analyzed with each batch

- A standard corresponding to the LOQ is analyzed with the batch and meets the established acceptance criteria
- The linearity is verified at the frequency established by the method or manufacturer.

All initial calibrations are verified with an initial calibration verification standard (ICV) obtained from a second manufacturer or second lot from the same manufacturer if the lot can be demonstrated as prepared independently from other lots prior to the analysis of samples. Sample results are quantitated from the initial calibration unless otherwise required by regulation, method, or program.

During the course of analysis, the calibration curve is periodically verified by the analysis of calibration verification standards (CCV). A calibration verification standard is analyzed within each analytical batch at method/program specific intervals to verify that the initial calibration is still valid. The CCV is also analyzed at the end of the analytical batch.

A calibration blank is also run with each calibration verification standard to verify the cleanliness of the system. All reported results must be bracketed by acceptable CCVs. Instrument and method specific calibration acceptance criteria are explained within the specific analytical standard operating procedures for each facility.

Interference check standards are also analyzed per method requirements and must meet acceptance criteria for metals analyses.

6.3. Support Equipment Calibration Procedures

All support equipment is calibrated or verified at least annually using NIST traceable references over the entire range of use. The results of calibrations or verifications must be within the specifications required or the equipment will be removed from service until repaired. The laboratory maintains records to demonstrate the correction factors applied to working thermometers.

On each day the equipment is used, balances, ovens, refrigerators (those used to keep samples and standards at required temperatures), freezers, and water baths are checked in the expected use range with NIST traceable references in order to ensure the equipment meets laboratory specifications and these checks are documented appropriately.

6.3.1. Analytical Balances

Each analytical balance is calibrated or verified at least annually by a qualified service technician. The calibration of each balance is verified each day of use prior to use with weights traceable to NIST bracketing the range of use. Calibration weights are ASTM Class 1 or other class weights that have been calibrated against a NIST standard weight and are re-certified annually against a NIST traceable reference. Some accrediting agencies may require more frequent checks. If balances are calibrated by an external agency, verification of their weights must be provided. All information pertaining to balance maintenance and calibration is recorded in the individual balance logbook and/or is maintained on file in the Quality department.

6.3.2. Thermometers

Certified, or reference, thermometers are maintained for checking calibration of working thermometers. Reference thermometers are provided with NIST traceability for initial calibration and are re-certified, at a minimum, every 3 years with equipment directly traceable to NIST.

Working thermometers are compared with the reference thermometers annually according to corporate metrology procedures. Each thermometer is individually numbered and assigned a correction factor based on the NIST reference source. In addition, working thermometers are visually inspected by laboratory personnel prior to use and temperatures are documented.

Laboratory thermometer inventory and calibration data are maintained in the Quality department.

6.3.3. pH/Electrometers

The meter is calibrated before use each day, using fresh buffer solutions. See method SOP S-MN-I-526 – pH, for more information.

6.3.4. Spectrophotometers

During use, spectrophotometer performance is checked at established frequencies in analysis sequences against initial calibration verification (ICV) and continuing calibration verification (CCV) standards.

6.3.5. Mechanical Volumetric Dispensing Devices

Mechanical volumetric dispensing devices including bottle top dispensers, pipettes, and burettes, excluding Class A volumetric glassware, are checked for accuracy on a quarterly basis. The accuracy of glass microliter syringes is verified and documented prior to initial use.

Additional information regarding calibration and maintenance of laboratory support equipment can be found in SOP S-MN-Q-264 ***Support Equipment*** or its equivalent revision or replacement.

6.4. Instrument/ Equipment Maintenance

The objectives of the Pace Analytical maintenance program are twofold: to establish a system of instrument care that maintains instrumentation and equipment at required levels of calibration and sensitivity, and to minimize loss of productivity due to repairs.

The Laboratory Operations Manager and department manager/supervisors are responsible for providing technical leadership to evaluate new equipment, solve equipment problems, and coordinate instrument repair and maintenance. Analysts have the primary responsibility to perform routine maintenance.

To minimize downtime and interruption of analytical work, preventative maintenance is routinely performed on each analytical instrument. Up-to-date instructions on the use and maintenance of equipment are available to staff in the department where the equipment is used.

Department manager/supervisors are responsible for maintaining an adequate inventory of spare parts required to minimize equipment downtime. This inventory includes parts and supplies that are subject to frequent failure, have limited lifetimes, or cannot be obtained in a timely manner should a failure occur.

All major equipment and instrumentation items are uniquely identified to allow for traceability. Equipment/instrumentation is, unless otherwise stated, identified as a system and not as individual pieces. The laboratory maintains equipment records that include the following:

- The name of the equipment and its software
- The manufacturer's name, type, and serial number
- Approximate date received and date placed into service
- Current location in the laboratory
- Condition when received (new, used, etc.)
- Copy of any manufacturer's manuals or instructions
- Dates and results of calibrations and next scheduled calibration (if known)
- Details of past maintenance activities, both routine and non-routine
- Details of any damage, modification or major repairs

All instrument maintenance is documented in maintenance logbooks or databases that are assigned to each particular instrument or system. A copy of the equipment list can be found in Attachment III.

When maintenance is performed to repair an instrument problem, depending on the initial problem, demonstration of return to control may be satisfied by the successful analysis of a tune, reagent blank, or continuing calibration standard depending on the instrument problem. The maintenance log entry must include a summary of the results of that analysis and verification by the analyst that the instrument has been returned to an in-control status. In addition, each entry must include the initials of the analyst making the entry, the dates the maintenance actions were performed, and the date the entry was made in the maintenance logbook, if different from the date(s) of the maintenance.

Any equipment that has been subjected to overloading or mishandling, or that gives suspect results, or has been shown to be defective, is taken out of service and clearly identified. The equipment shall not be used to analyze customer samples until it has been repaired and shown to perform satisfactorily.

7.0. CONTROL OF DATA

Analytical results processing, verification, and reporting are procedures employed that result in the delivery of defensible data. These processes include, but are not limited to, calculation of raw data into final concentration values, review of results for accuracy, evaluation of quality control criteria and assembly of technical reports for delivery to the data user.

All analytical data undergo a well-defined, well-documented multi-tier review process prior to being reported to the customer. This section describes procedures used by PASI for translating raw analytical data into accurate final sample reports as well as PASI data storage policies.

7.1. Analytical Results Processing

When analytical, field, or product testing data is generated, it is either recorded in a bound laboratory logbook (e.g. Run log or Instrument log) or copies of computer-generated printouts that are appropriately labeled and filed. These logbooks and other laboratory records are kept in accordance with each facility's Standard Operating Procedure for documentation storage and archival. If the laboratory chooses to minimize or eliminate its paper usage, these records can be kept on electronic media. In this case, the laboratory must ensure that there are sufficient redundant electronic copies so no data is lost due to unforeseen computer issues.

The primary analyst is responsible for initial data reduction and review. This includes confirming compliance with required methodology, verifying calculations, evaluating quality control data, noting non-conformances in logbooks or as footnotes or narratives, and uploading analytical results into the LIMS.

The primary analyst then compiles the initial data package for verification. This compilation must include sufficient documentation for data review. It may include standard calibrations, chromatograms, manual integration documentation, electronic printouts, chain of custody forms, and logbook copies.

Some agencies or customers require different levels of data reporting. For these special levels, the primary analyst may need to compile additional project information, such as initial calibration data or extensive spectral data, before the data package proceeds to the verification step.

7.2. Data Verification

Data verification is the process of examining data and accepting or rejecting it based on pre-defined criteria. This review step is designed to ensure that reported data are free from calculation and transcription errors, that quality control parameters are evaluated, and that any non-conformances are properly documented.

Analysts performing the analysis and subsequent data reduction have primary responsibility for quality of the data produced. The primary analyst initiates the data verification process by reviewing and accepting the data, provided QC criteria have been met for the samples being reported. Data review checklists, either hardcopy or electronic, are used to document the data review process. The primary analyst is responsible for the initial input of the data into the LIMS.

The completed data package is then sent to a designated qualified reviewer (this cannot be the primary analyst). The following criteria have been established to qualify someone as a data reviewer. To perform secondary data reviewer, the reviewer must:

1. Have a current Demonstration of Capability (DOC) study on file and have an SOP acknowledgement form on file for the method/procedure being reviewed; or, See Note

2. Have a DOC on file for a similar method/technology (i.e. GC/MS) and have an SOP acknowledgment form on file for the method/procedure being reviewed; or, See Note

3. Supervise or manage a Department and have an SOP acknowledgment form on file for the method/procedure being reviewed; or,

4. Have significant background in the department/methods being reviewed through education or experience and have an SOP acknowledgment form on file for the method/procedure being reviewed.

Note: Secondary reviewer status must be approved personally by the Quality Manager or General Manager in the event that this person has no prior experience on the specific method or general technology.

This reviewer provides an independent technical assessment of the data package and technical review for accuracy according to methods employed and laboratory protocols. This assessment involves a quality control review for use of the proper methodology and detection limits, compliance to quality control protocol and criteria, presence and completeness of required deliverables, and accuracy of calculations and data quantitation. The reviewer also validates the data entered into the LIMS.

Once the data have been technically reviewed and approved, authorization for release of the data from the analytical section is indicated by initialing and dating the data review checklist or otherwise initialing and dating the data (or designating the review of data electronically). The Operations or Project Manager examines the report for method appropriateness, detection limits and QC acceptability. Any deviations from the referenced methods are checked for documentation and validity, and QC corrective actions are reviewed for successful resolution.

Additional information regarding data review procedures can be found in SOP S-MN-L-132 ***Data Reduction, Validation, and Reporting in the Environmental Laboratory*** or its equivalent revision or replacement.

7.3. Data Reporting

Data for each analytical fraction pertaining to a particular PASI project number are delivered to the Project Manager for assembly into the final report. All points mentioned during technical and QC reviews are included in a case narrative if there is potential for data to be impacted.

Final reports are prepared according to the level of reporting required by the customer and can be transmitted to the customer via hardcopy or electronic deliverable. A standard PASI final report consists of the following components:

1. A title which designates the report as “Final Report”, “Laboratory Results”, “Certificate of Results”, etc.
2. Name and address of laboratory (or subcontracted laboratories, if used).
3. Phone number and name of laboratory contact to where questions can be referred.

4. A unique identification number for the report. The pages of the report shall be numbered and a total number of pages shall be indicated.
5. Name and address of customer and name of project
6. Unique identification of samples analyzed as well as customer sample IDs.
7. Identification of any sample that did not meet acceptable sampling requirements of the relevant governing agency, such as improper sample containers, holding times missed, sample temperature, etc.
8. Date and time of collection of samples, date of sample receipt by the laboratory, dates of sample preparation and analysis, and times of sample preparation and analysis when the holding time for either is 72 hours or less.
9. Identification of the test methods used.
10. Identification of sampling procedures if sampling was conducted by the laboratory.
11. Deviations from, additions to, or exclusions from the test methods. These can include failed quality control parameters, deviations caused by the matrix of the sample, etc., and can be shown as a case narrative or as defined footnotes to the analytical data.
12. Identification of whether calculations were performed on a dry or wet-weight basis.
13. Reporting limits used.
14. Final results or measurements, supported by appropriate chromatograms, charts, tables, spectra, etc.
15. A signature and title, electronic or otherwise, of person accepting responsibility for the content of the report.
16. Date report was issued.
17. A statement clarifying that the results of the report relate only to the samples tested or to the samples as they were received by the laboratory.
18. If necessary, a statement indicating that the report must not be reproduced except in full, without the written approval of the laboratory.
19. Identification of all test results provided by a subcontracted laboratory or other outside source.
20. Identification of results obtained outside of quantitation levels.

In addition to the requirements listed above, final reports shall also contain the following items when necessary for the interpretation of results:

21. Deviations from, additions to, or exclusions from the test method, and information on specific test conditions, such as environmental conditions.
22. Where relevant, a statement of compliance/non-compliance with requirements and/or specifications (e.g., the TNI standard).
23. Where applicable, a statement on the estimated uncertainty of measurement; information on uncertainty is needed in test reports when it is relevant to the validity or application of the test results, when a customer's instruction so requires, or when the uncertainty affects compliance to a specification limit.
24. Where appropriate and needed, opinions and interpretations, which may include opinions on the compliance/non-compliance of the results with requirements, fulfillment of contractual requirements, recommendations on how to use the results, and guidance to be used for improvement.
25. Additional information which may be required by specific methods, regulatory agencies, or customers.

Additional items may be required per Client QAPPs or different state regulations, i.e. Affidavit for Ohio VAP reports.

For DoD labs, in reference to item 8 listed above, both date and time of preparation and analysis are considered essential information, regardless of the length of the holding time, and shall be included as part of the laboratory report.

Any changes made to a final report shall be designated as "Revised" or equivalent wording. The laboratory must keep sufficient archived records of all laboratory reports and revisions. For higher levels of data deliverables, a copy of all supporting raw data is sent to the customer along with a final report of results. When possible, the PASI facility will provide electronic data deliverables (EDD) as required by contracts or upon customer request.

Customer data that requires transmission by telephone, telex, facsimile or other electronic means undergoes appropriate steps to preserve confidentiality.

The following positions are the only approved signatories for PASI final reports:

- Senior General Manager
- General Manager
- Quality Manager
- Client Services Manager
- Project Manager
- Project Coordinator

7.4. Data Security

All data including electronic files, logbooks, extraction/digestion/distillation worksheets, calculations, project files and reports, and any other information used to produce the technical report are maintained secured and retrievable by the PASI facility.

7.5. Data Archiving

All records compiled by PASI are maintained legible and retrievable and stored secured in a suitable environment to prevent loss, damage, or deterioration by fire, flood, vermin, theft, and/or environmental deterioration. Records are retained for a minimum of five years unless superseded by federal, state, contractual, and/or accreditation requirements. These records may include, but are not limited to, customer data reports, calibration and maintenance of equipment, raw data from instrumentation, quality control documents, observations, calculations, and logbooks. These records are retained in order to provide for possible historical reconstruction including sampling, receipt, preparation, analysis, and personnel involved. NELAP-related records will be made readily available to accrediting authorities. Access to archived data is documented and controlled by the Quality Manager or a designated Data Archivist.

Records that are computer generated have either a hard copy or electronic write protected backup copy. Hardware and software necessary for the retrieval of electronic data is maintained with the applicable records. Archived electronic records are stored protected against electronic and/or magnetic sources.

In the event of a change in ownership, accountability or liability, reports of analyses performed pertaining to accreditation will be maintained by the acquiring entity for a minimum of five years. In

the event of bankruptcy, laboratory reports and/or records will be transferred to the customer and/or the appropriate regulatory entity upon request.

For Ohio VAP labs, all records must be maintained for 10 years.

7.6. Data Disposal

Data that has been archived for the facility's required storage time may be disposed of in a secure manner by shredding, returning to customer, or utilizing some other means that does not jeopardize data confidentiality. Records of data disposal will be archived for a minimum of five years unless superseded by federal, contractual, and/or accreditation requirements.

For Ohio VAP labs, all records must be maintained for 10 years.

8.0. QUALITY SYSTEM AUDITS AND REVIEWS

8.1. Internal Audits

8.1.1. Responsibilities

The Quality Manager is responsible for designing and/or conducting internal audits in accordance with a predetermined schedule and procedure. Since internal audits represent an independent assessment of laboratory functions, the auditor must be functionally independent from laboratory operations to ensure objectivity. The auditor must be trained, qualified, and familiar enough with the objectives, principles, and procedures of laboratory operations to be able to perform a thorough and effective evaluation. The Quality Manger evaluates audit observations and verifies the completion of corrective actions. In addition, a periodic corporate audit will be conducted. The corporate audits will focus on the effectiveness of the Quality System as outlined in this manual but may also include other quality programs applicable to an individual laboratory.

8.1.2. Scope and Frequency of Internal Audits

The complete internal audit process consists of the following four sections:

- Raw Data Review audits- conducted according to a schedule per local Quality Manager. A certain number of these data review audits are conducted per quarter to accomplish this yearly schedule.
- Quality System audits- considered the traditional internal audit function and include analyst interviews to help determine whether practice matches method requirements and SOP language.
- Final Report reviews
- Corrective Action Effectiveness Follow-up

Internal systems audits are conducted yearly at a minimum. The scope of these audits includes evaluation of specific analytical departments or a specific quality related system as applied throughout the laboratory.

Examples of system-wide elements that can be audited include:

- Quality Systems documents, such as Standard Operating Procedures, training documents, Quality Assurance Manual, and all applicable addenda
- Data records and non-technical documents
- Personnel and training files.
- General laboratory safety protocols.
- Chemical handling practices, such as labeling of reagents, solutions, and standards as well as all associated documentation.
- Documentation concerning equipment and instrumentation, calibration/maintenance records, operating manuals.
- Sample receipt and management practices.
- Analytical documentation, including any discrepancies and corrective actions.
- General procedures for data security, review, documentation, reporting, and archiving.

- Data integrity issues such as proper manual integrations.

When the operations of a specific department are evaluated, a number of additional functions are reviewed including:

- Detection limit studies
- Internal chain of custody documentation
- Documentation of standard preparations
- Quality Control limits and Control charts

Certain projects may require an internal audit to ensure laboratory conformance to site work plans, sampling and analysis plans, QAPPs, etc.

A representative number of data audits are completed annually. The report format of any non-conformance is similar to that of other internal audits.

The laboratory, as part of their overall internal audit program, ensures that a review is conducted with respect to any evidence of inappropriate actions or vulnerabilities related to data integrity. Discovery and reporting of potential data integrity issues are handled in a confidential manner. All investigations that result in findings of inappropriate activity are fully documented, including the source of the problem, the samples and customers affected the impact on the data, the corrective actions taken by the laboratory, and which final reports had to be re-issued. Customers must be notified within 30 days after the data investigation is completed and the impact to final results is assessed.

8.1.3. Internal Audit Reports and Corrective Action Plans

Additional information can be found in SOP S-ALL-Q-011 ***Audits and Inspections*** or its equivalent revision or replacement.

A full description of the audit, including the identification of the operation audited, the date(s) on which the audit was conducted, the specific systems examined, and the observations noted are summarized in an internal audit report. Although other personnel may assist with the performance of the audit, the Quality Manager writes and issues the internal audit report identifying which audit observations are deficiencies that require corrective action.

When audit findings cast doubt on the effectiveness of the operations or on the correctness of validity of the laboratory's environmental test results, the laboratory will take timely corrective action and notify the customer in writing within three business days, if investigations show that the laboratory results may have been affected.

Once completed, the internal audit report is issued jointly to the Laboratory General Manager and the manager(s)/supervisor(s) of the audited operation at a minimum. The responsible manager(s)/supervisor(s) responds within 14 days with a proposed plan to correct all of the deficiencies cited in the audit report. The Quality Manager may grant additional time for responses to large or complex deficiencies (not to exceed 30 days). Each response must include timetables for completion of all proposed corrective actions.

The Quality Manager reviews the audit responses. If the response is accepted, the Quality Manager uses the action plan and timetable as a guideline for verifying completion of the corrective action(s). If the Quality Manager determines that the audit response does not adequately address the correction of cited deficiencies, the response will be returned for modification.

To complete the audit process, the Quality Manager performs a re-examination of the areas where deficiencies were found to verify that all proposed corrective actions have been implemented. An audit deficiency is considered closed once implementation of the necessary corrective action has been audited and verified. This is usually within 60-90 days after implementation. If corrective action cannot be verified, the associated deficiency remains open until that action is completed.

8.2. External Audits

PASI laboratories are audited regularly by regulatory agencies to maintain laboratory certifications and by customers to maintain appropriate specific protocols.

Audit teams external to the company review the laboratory to assess the effectiveness of systems and degree of technical expertise. The Quality Manager and other QA staff host the audit team and assist in facilitation of the audit process. Generally, the auditors will prepare a formalized audit report listing deficiencies observed and follow-up requirements for the laboratory. In some cases, items of concern are discussed during a debriefing convened at the end of the on-site review process.

The laboratory staff and supervisors develop corrective action plans to address any deficiencies with the guidance of the Quality Manager. The Laboratory General Manager provides the necessary resources for staff to develop and implement the corrective action plans. The Quality Manager collates this information and provides a written response to the audit team. The response contains the corrective action plan and expected completion dates for each element of the plan. The Quality Manager follows-up with the laboratory staff to ensure corrective actions are implemented and that the corrective action was effective.

8.3. Quarterly Quality Reports

The Quality Manager is responsible for preparing a quarterly report to management summarizing the effectiveness of the laboratory Quality Systems. This status report will include:

- Overview of quality activities for the quarter
- Certification status
- Proficiency Testing study results
- SOP revision activities
- Company-wide 3P Document implementation (internal program)
- External audit findings
- Internal audit (method/system) findings
- Manual integration audit findings (Mintminer)
- Raw Data and Final Report review findings
- MDL activities
- Corrective action activities
- Training activity status

- Other significant Quality System items

The Corporate Director of Quality utilizes the information from each laboratory to make decisions impacting the Quality Systems of the company as a whole. Each General Manager utilizes the quarterly report information to make decisions impacting Quality Systems and operational systems at a local level.

Additional information can be found in SOP S-ALL-Q-014 ***Quality System Review*** or its equivalent revision or replacement.

8.4. Annual Managerial Review

A managerial review of Quality Systems is performed on an annual basis at a minimum. This allows for assessing program effectiveness and introducing changes and/or improvements.

The managerial review must include the following topics of discussion:

- Suitability of quality management policies and procedures
- Manager/Supervisor reports
- Internal audit results
- Corrective and preventative actions
- External assessment results
- Proficiency testing studies
- Sample capacity and scope of work changes
- Customer feedback, including complaints
- Recommendations for improvement,
- Other relevant factors, such as quality control activities, resources, and staffing.

This managerial review must be documented for future reference by the Quality Manager and copies of the report are distributed to laboratory staff. Results should feed into the laboratory planning system and should include goals, objectives, and action plans for the coming year. The laboratory shall ensure that any actions identified during the review are carried out within an appropriate and agreed upon timescale.

8.5. Customer Service Reviews

As part of the annual managerial review listed previously, the sales staff is responsible for reporting on customer feedback, including complaints. The acquisition of this information is completed by performing surveys.

The sales staff continually receives customer feedback, both positive and negative, and reports this feedback to the laboratory management in order for them to evaluate and improve their management system, testing activities and customer service.

In addition, the labs must be willing to cooperate with customers or their representatives to clarify customer requests and to monitor the laboratory's performance in relation to the work being performed for the customers.

9.0. CORRECTIVE ACTION

Additional information can be found in SOP S-MN-Q-262 ***Corrective Action/Preventive Action Process*** or its equivalent revision or replacement.

During the process of sample handling, preparation, and analysis, or during review of quality control records, or during reviews of non-technical portions of the lab, certain occurrences may warrant the necessity of corrective actions. These occurrences may take the form of analyst errors, deficiencies in quality control, method deviations, or other unusual circumstances. The Quality System of PASI provides systematic procedures for the documentation, monitoring, completion of corrective actions, and follow-up verification of the effectiveness of these corrective actions. This can be done using PASI's LabTrack system or other system that lists among at a minimum, the deficiency by issue number, the deficiency source, responsible party, root cause, resolution, due date, and date resolved.

9.1. Corrective Action Documentation

The following items are examples of sources of laboratory deviations or non-conformances that warrant some form of documented corrective action:

- Internal Laboratory Non-Conformance Trends
- PE/PT Sample Results
- Internal and External Audits
- Data or Records Review (including non-technical records)
- Client Complaints
- Client Inquiries
- Holding Time violations

Documentation of corrective actions may be in the form of a comment or footnote on the final report that explains the deficiency (e.g. matrix spike recoveries outside of acceptance criteria) or it may be a more formal documentation (either paper system or computerized spreadsheet). This depends on the extent of the deficiency, the impact on the data, and the method or customer requirements for documentation.

The person who discovers the deficiency or non-conformance initiates the corrective action documentation on the Non-Conformance Corrective/ Preventative Action report and/or LabTrack. The documentation must include the affected projects and sample numbers, the name of the applicable Project Manager, the customer name, and the sample matrix involved. The person initiating the corrective action documentation must also list the known causes of the deficiency or non-conformance as well as any corrective/preventative actions that they have taken. Preventive actions must be taken in order to prevent or minimize the occurrence of the situation.

In the event that the laboratory is unable to determine the cause, laboratory personnel and management staff will start a root cause analysis by going through an investigative process. During this process, the following general steps must be taken into account: defining the non-conformance, assigning responsibilities, determining if the condition is significant, and investigating the root cause of the nonconformance. General non-conformance investigative techniques follow the path of the sample through the process looking at each individual step in detail. The root cause must be documented within Lab Track or on the Corrective/Preventative Action Report.

After all the documentation is completed, the routing of the Corrective/Preventative Action Report and /or Lab Track will continue from the person initiating the corrective action, to their immediate supervisor or the Project Manager and finally to the Quality Manager, who is responsible for final review and signoff of all formal corrective/preventative actions.

In the event that analytical testing or results do not conform to laboratory procedures or customer requirements, the laboratory shall investigate the significance of the non-conformance and take appropriate corrective actions. Where necessary, the customer is notified and work is recalled. The procedures for handling non-conforming work are detailed in SOP S-MN-Q-262 ***Corrective Action/Preventive Action Process*** or its equivalent revision or replacement.

9.2. Corrective Action Completion

9.2.1. Internal Laboratory Non-Conformance Trends

There are several types of non-conformance trends that may occur in the laboratory that would require the initiation of a corrective action report. Laboratories may choose to initiate a corrective action for all instances of one or more of these categories if they so choose, however the intent is that each of these would be handled according to its severity; one time instances could be handled with a footnote or qualifier whereas a systemic problem with any of these categories may require an official corrective action process. These categories, as defined in the Corrective Action SOP are as follows:

- Login error
- Preparation Error
- Contamination
- Calibration Failure
- Internal Standard Failure
- LCS Failure
- Laboratory accident
- Spike Failure
- Instrument Failure
- Final Reporting error

9.2.2. PE/PT Sample Results

Any PT result assessed as “not acceptable” requires an investigation and applicable corrective actions. The operational staff is made aware of the PT failures and they are responsible for reviewing the applicable raw data and calibrations and list possible causes for error. The Quality Manager reviews their findings and initiates another external PT sample or an internal PT sample to try and correct the previous failure. Replacement PT results must be monitored by the Quality Manager and reported to the applicable regulatory authorities.

9.2.3. Internal and External Audits

The Quality Manager is responsible for documenting all audit findings and their corrective actions. This documentation must include the initial finding, the persons responsible for the corrective

action, the due date for responding to the auditing body, the root cause of the finding, and the corrective actions needed for resolution. The Quality Manager is also responsible for providing any back-up documentation used to demonstrate that a corrective action has been completed.

9.2.4. Data Review

In the course of performing primary and secondary review of data or in the case of raw data reviews (e.g. by the Quality Manager), errors may be found which require corrective actions. Any finding that affects the quality of the data requires some form of corrective action, which may include revising and re-issuing of final reports.

9.2.5. Client Complaints

Project Managers and Sales staff are responsible for issuing corrective action forms, when warranted, for customer complaints. As with other corrective actions, the possible causes of the problem are listed and the form is passed to the appropriate analyst or supervisor for investigation. After potential corrective actions have been determined, the Project Manager reviews the corrective action form to ensure all customer needs or concerns are being adequately addressed.

9.2.6. Client Inquiries

When an error on the customer report is discovered, the Project Manager is responsible for initiating a formal corrective action form that describes the failure (e.g. incorrect analysis reported, reporting units are incorrect, reporting limits do not meet objectives). The Project Manager is also responsible for revising the final report if necessary and submitting it to the customer.

9.2.7. Holding Time Violations

In the event that a holding time has been missed, the analyst or supervisor must complete a formal corrective action form or generate a Labtrack ticket. The Project Manager and the Quality Manager must be made aware of all holding time violations.

The Project Manager must contact the customer in order that appropriate decisions are made regarding the hold time excursion and the ultimate resolution is then documented and included in the customer project file. The Quality Manager includes a list of all missed holding times in their Quarterly Report to the corporate QA office.

9.3. Preventive Action Documentation

Pace laboratories can take advantage of several available information sources in order to identify needed improvements in all of their systems including technical, managerial, and quality. These sources may include:

- Management Continuous Improvement Plan (CIP) metrics which are used by all production departments within Pace. When groups compare performance across the company, ways to improve systems may be discovered. These improvements can be made within a department or laboratory-wide.

- Annual managerial reviews- part of this NELAC required and NVLAP required review is to look at all processes and procedures used by the laboratory over the past year and to determine ways to improve these processes in the future.
- Quality systems reviews- any frequent checks of quality systems (monthly logbook reviews, etc.) can uncover issues that can be corrected or adjusted before they become a larger issue.

When improvement opportunities are identified or if preventive action is required, the laboratory can develop, implement, and monitor preventive action plans.

10.0. GLOSSARY

3P Program	The Pace Analytical continuous improvement program that focuses on Process, Productivity, and Performance. Best Practices are identified that can be used by all PASI labs.
Acceptance Criteria	Specified limits placed on characteristics of an item, process, or service defined in requirement documents.
Accreditation	The process by which an agency or organization evaluates and recognizes a laboratory as meeting certain predetermined qualifications or standards, thereby accrediting the laboratory. In the context of NELAP, this process is voluntary.
Accrediting Authority	The Territorial, State or Federal agency having responsibility and accountability for environmental laboratory accreditation and which grants accreditation.
Accrediting (or Accreditation) Body	Authoritative body that performs accreditation.
Accuracy	The degree of agreement between an observed value and an accepted reference value. Accuracy includes a combination of random error (precision) and systematic error (bias) components that are due to sampling and analytical operations; a data quality indicator.
Aliquot	A discrete, measured, representative portion of a sample taken for analysis.
Analysis Code (Acode)	All the set parameters of a test, such as Analytes, Method, Detection Limits and Price.
Analyst	The designated individual who performs the "hands-on" analytical methods and associated techniques and who is responsible for applying required laboratory practices and other pertinent quality controls to meet the required level of quality.
Analyte	The specific chemicals or components for which a sample is analyzed; it may be a group of chemicals that belong to the same chemical family, and which are analyzed together.
Analytical Uncertainty	A subset of Measurement Uncertainty that includes all laboratory activities performed as part of the analysis.
Assessment	The evaluation process used to measure the performance or effectiveness of a system and its elements against specific criteria (this is an all-inclusive term used to denote any of the following: audit, performance evaluation, peer review, inspection or surveillance).
Atomic Absorption Spectrometer	Instrument used to measure concentration in metals samples.
Atomization	A process in which a sample is converted to free atoms.
Audit	A systematic and independent examination of facilities, equipment, personnel, training, procedures, record-keeping, data validation, data management, and reporting aspects of a system to determine whether QA/QC and technical activities are being conducted as planned and whether these activities will effectively achieve quality objectives.

Batch	Environmental samples that are prepared and/or analyzed together with the same process and personnel, using the same lot(s) of reagents. A preparation batch is composed of one to 20 environmental samples of the same quality systems matrix, meeting the above-mentioned criteria and with a maximum time between the start of processing of the first and last sample in the batch to be 24 hours. An analytical batch is composed of prepared environmental samples (extracts, digestates or concentrates) that are analyzed together as a group. An analytical batch can include prepared samples originating from various environmental matrices and can exceed 20 samples.
Bias	The systematic or persistent distortion of a measurement process, which causes errors in one direction (i.e., the expected sample measurement is different from the sample's true value).
Blank	A sample that has not been exposed to the analyzed sample stream in order to monitor contamination during sampling, transport, storage or analysis. The blank is subjected to the usual analytical and measurement process to establish a zero baseline or background value and is sometimes used to adjust or correct routine analytical results.
Blind Sample	A sample submitted for analysis with a composition known to the submitter. The analyst/laboratory may know the identity of the sample but not its composition. It is used to test analyst or laboratory proficiency in the execution of the measurement process.
BNA (Base Neutral Acid compounds)	A list of semi-volatile compounds typically analyzed by mass spectrometry methods. Named for the way they can be extracted out of environmental samples in an acidic, basic or neutral environment.
BOD (Biochemical Oxygen Demand)	Chemical procedure for determining how fast biological organisms use up oxygen in a body of water.
Calibration	Set of operations that establish, under specified conditions, the relationship between values of quantities indicated by a measuring instrument or measuring system, or values represented by a material measure or a reference material, and the corresponding values realized by standards. 1) In calibration of support equipment, the values realized by standards are established through the use of Reference Standards that are traceable to the International System of Units (SI); 2) In calibration according to test methods, the values realized by standards are typically established through the use of Reference Materials that are either purchased by the laboratory with a certificate of analysis or purity, or prepared by the laboratory using support equipment that has been calibrated or verified to meet specifications.
Calibration Curve	The graphical relationship between the known values, such as concentrations, of a series of calibration standards and their instrument response.
Calibration Method	A defined technical procedure for performing a calibration.
Calibration Range	The range of values (concentrations) between the lowest and highest calibration standards of a multi-level calibration curve. For metals analysis with a single-point calibration, the low-level calibration check standard and the high standard establish the linear calibration range, which lies within the linear dynamic range.
Calibration Standard	A substance or reference material used to calibrate an instrument.

Certified Reference Material (CRM)	A reference material one or more of whose property values are certified by a technically valid procedure, accompanied by or traceable to a certificate or other documentation which is issued by a certifying body.
Chain of Custody	An unbroken trail of accountability that verifies the physical security of samples, data, and records.
Chain of custody Form (COC)	A record that documents the possession of samples from the time of collection to receipt in the laboratory. This record generally includes the number and type of containers, mode of collection, collector, time of collection, preservation, and requested analyses.
Chemical Oxygen Demand (COD)	A test commonly used to indirectly measure the amount of organic compounds in water.
Client (referred to by ISO as Customer)	Any individual or organization for whom items or services are furnished or work performed in response to defined requirements and expectations.
Code of Federal Regulations (CFR)	A codification of the general and permanent rules published in the Federal Register by agencies of the federal government.
Comparability	An assessment of the confidence with which one data set can be compared to another. Comparable data are produced through the use of standardized procedures and techniques.
Completeness	The percent of valid data obtained from a measurement system compared to the amount of valid data expected under normal conditions. The equation for completeness is: % Completeness = (Valid Data Points/Expected Data Points)*100
Confirmation	Verification of the identity of a component through the use of an approach with a different scientific principle from the original method. These may include, but are not limited to: • second-column confirmation; • alternate wavelength; • derivatization; • mass spectral interpretation; • alternative detectors; or • additional cleanup procedures.
Conformance	An affirmative indication or judgment that a product or service has met the requirements of the relevant specifications, contract, or regulation; also the state of meeting the requirements.
Congener	A member of a class of related chemical compounds (e.g. PCBs, PCDDs).
Consensus Standard	A standard established by a group representing a cross-section of a particular industry or trade, or a part thereof.
Continuing Calibration Blank (CCB)	A blank sample used to monitor the cleanliness of an analytical system at a frequency determined by the analytical method.
Continuing Calibration Check Compounds (CCC)	Compounds listed in mass spectrometry methods that are used to evaluate an instrument calibration from the standpoint of the integrity of the system. High variability would suggest leaks or active sites on the instrument column.

Continuing Calibration Verification	The verification of the initial calibration that is required during the course of analysis at periodic intervals. Continuing calibration verification applies to both external and internal standard calibration techniques, as well as to linear and non-linear calibration models.
Continuing Calibration Verification (CCV) Standard	Also referred to as a CVS in some methods, it is a standard used to verify the initial calibration of compounds in an analytical method. CCVs are analyzed at a frequency determined by the analytical method.
Continuous Emission Monitor (CEM)	A flue gas analyzer designed for fixed use in checking for environmental pollutants.
Contract Laboratory Program (CLP)	A national network of EPA personnel, commercial labs, and support contractors whose fundamental mission is to provide data of known and documented quality.
Contract Required Detection Limit (CRDL)	Detection limit that is required for EPA Contract Laboratory Program (CLP) contracts.
Contract Required Quantitation Limit (CRQL)	Quantitation limit (reporting limit) that is required for EPA Contract Laboratory Program (CLP) contracts.
Control Chart	A graphic representation of a series of test results, together with limits within which results are expected when the system is in a state of statistical control (see definition for Control Limit)
Control Limit	A range within which specified measurement results must fall to verify that the analytical system is in control. Control limit exceedances may require corrective action or require investigation and flagging of non-conforming data.
Corrective Action	The action taken to eliminate the causes of an existing non-conformity, defect, or other undesirable situation in order to prevent recurrence.
Corrective and Preventative Action (CAPA)	The primary management tools for bringing improvements to the quality system, to the management of the quality system's collective processes, and to the products or services delivered which are an output of established systems and processes.
Data Audit	A qualitative and quantitative evaluation of the documentation and procedures associated with environmental measurements to verify that the resulting data are of acceptable quality (i.e. that they meet specified acceptance criteria).
Data Quality Objective (DQO)	Systematic strategic planning tool based on the scientific method that identifies and defines the type, quality, and quantity of data needed to satisfy a specified use or end user.
Data Reduction	The process of transforming raw data by arithmetic or statistical calculations, standard curves, concentration factors, etc., and collation into a more usable form.
Definitive Data	Analytical data of known quality, concentration and level of uncertainty. The levels of quality and uncertainty of the analytical data are consistent with the requirements for the decision to be made. Suitable for final decision-making.
Demonstration of Capability	A procedure to establish the ability of the analyst to generate analytical results of acceptable accuracy and precision.
Detection Limit (DL)	The smallest analyte concentration that can be demonstrated to be different than zero or a blank concentration at the 99% level of confidence. At the DL, the false positive rate is 1%.

Diesel Range Organics (DRO)	A range of compounds that denote all the characteristic compounds that make up diesel fuel (range can be state or program specific).
Digestion	A process in which a sample is treated (usually in conjunction with heat) to convert the sample to a more easily measured form.
Document Control (Management)	The act of ensuring that documents (and revisions thereto) are proposed, reviewed for accuracy, approved for release by authorized personnel, distributed properly and controlled (managed) to ensure use of the correct version at the location where the prescribed activity is performed.
Dry Weight	The weight after drying in an oven at a specified temperature.
Duplicate (or Replicate)	The analyses or measurements of the variable of interest performed identically on two subsamples of the same sample. The results of duplicate analyses are used to evaluate analytical or measurement precision but not the precision of sampling, preservation or storage internal to the laboratory.
Electron Capture Detector (ECD)	Device used in GC methods to detect compounds that absorb electrons (e.g. PCB compounds).
Electronic Data Deliverable (EDD)	A summary of environmental data (usually in spreadsheet form) which clients request for ease of data review and comparison to historical results.
Eluent	A solvent used to carry the components of a mixture through a stationary phase.
Elute	To extract, specifically, to remove (absorbed material) from an absorbent by means of a solvent.
Elution	A process in which solutes are washed through a stationary phase by movement of a mobile phase.
Environmental Data	Any measurements or information that describe environmental processes, locations, or conditions; ecological or health effects and consequences; or the performance of environmental technology.
Environmental Monitoring	The process of measuring or collecting environmental data.
Environmental Sample	A representative sample of any material (aqueous, non-aqueous, or multimedia) collected from any source for which determination of composition or contamination is requested or required. Environmental samples can generally be classified as follows: • Non Potable Water (Includes surface water, ground water, effluents, water treatment chemicals, and TCLP leachates or other extracts) • Drinking Water - Delivered (treated or untreated) water designated as potable water • Water/Wastewater - Raw source waters for public drinking water supplies, ground waters, municipal influents/effluents, and industrial influents/effluents • Sludge - Municipal sludges and industrial sludges. • Soil - Predominately inorganic matter ranging in classification from sands to clays. • Waste - Aqueous and non-aqueous liquid wastes, chemical solids, and industrial liquid and solid wastes
Equipment Blank	A sample of analyte-free media used to rinse common sampling equipment to check effectiveness of decontamination procedures.

False Negative	An analyte incorrectly reported as absent from the sample, resulting in potential risks from their presence.
False Positive	An item incorrectly identified as present in the sample, resulting in a high reporting value for the analyte of concern.
Field Blank	A blank sample prepared in the field by filling a clean container with reagent water and appropriate preservative, if any, for the specific sampling activity being undertaken.
Field Measurement	Determination of physical, biological, or radiological properties, or chemical constituents that are measured on-site, close in time and space to the matrices being sampled/measured, following accepted test methods. This testing is performed in the field outside of a fixed-laboratory or outside of an enclosed structure that meets the requirements of a mobile laboratory.
Field of Accreditation	Those matrix, technology/method, and analyte combinations for which the accreditation body offers accreditation.
Finding	An assessment conclusion that identifies a condition having a significant effect on an item or activity. An assessment finding may be positive or negative and is normally accompanied by specific examples of the observed condition. (For DoD, the finding must be linked to a specific requirement).
Flame Atomic Absorption Spectrometer (FAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the fact that ground state metals absorb light at different wavelengths. Metals in a solution are converted to the atomic state by use of a flame.
Flame Ionization Detector (FID)	A type of gas detector used in GC analysis where samples are passed through a flame which ionizes the sample so that various ions can be measured.
Gas Chromatography (GC)	Instrumentation which utilizes a mobile carrier gas to deliver an environmental sample across a stationary phase with the intent to separate compounds out and measure their retention times.
Gas Chromatograph/ Mass Spectrometry (GC/MS)	In conjunction with a GC, this instrumentation utilizes a mass spectrometer which measures fragments of compounds and determines their identity by their fragmentation patterns (mass spectra).
Gasoline Range Organics (GRO)	A range of compounds that denote all the characteristic compounds that make up gasoline (range can be state or program specific).
Graphite Furnace Atomic Absorption Spectrometry (GFAA)	Instrumentation used to measure the concentration of metals in an environmental sample based on the absorption of light at different wavelengths that are characteristic of different analytes.
High Pressure Liquid Chromatography (HPLC)	Instrumentation used to separate, identify and quantitate compounds based on retention times which are dependent on interactions between a mobile phase and a stationary phase.
Holding Time	The maximum time that samples may be held prior to preparation and/or analysis as defined by the method and still be considered valid or not compromised (40 CFR Part 136). (DoD) The time elapsed from the time of sampling to the time of extraction or analysis, or from extraction to analysis, as appropriate.
Homogeneity	The degree to which a property or substance is uniformly distributed throughout a sample.
Homologue	One in a series of organic compounds in which each successive member has one more chemical group in its molecule than the next preceding member.

Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES)	Analytical technique used for the detection of trace metals which uses plasma to produce excited atoms that emit radiation of characteristic wavelengths.
Inductively Coupled Plasma- Mass Spectrometry (ICP/MS)	An ICP-AES that is used in conjunction with a mass spectrometer so that the instrument is not only capable of detecting trace amounts of metals and non-metals but is also capable of monitoring isotopic speciation for the ions of choice.
Infrared Spectrometer (IR)	An instrument that uses infrared light to identify compounds of interest.
Initial Calibration (ICAL)	The process of analyzing standards, prepared at specified concentrations, to define the quantitative response relationship of the instrument to the analytes of interest. Initial calibration is performed whenever the results of a calibration verification standard do not conform to the requirements of the method in use or at a frequency specified in the method.
Initial Calibration Verification (ICV)	A standard obtained or prepared from a source independent of the source of the standards for the initial calibration. Its concentration should be at or near the middle of the calibration range. It is done after the initial calibration.
Inspection	An activity such as measuring, examining, testing, or gauging one or more characteristics of an entity and comparing the results with specified requirements in order to establish whether conformance is achieved for each characteristic.
Instrument Blank	A clean sample (e.g., distilled water) processed through the instrumental steps of the measurement process; used to determine instrument contamination.
Interference, spectral	Occurs when particulate matter from the atomization scatters incident radiation from the source or when the absorption or emission from an interfering species either overlaps or is so close to the analyte wavelength that resolution becomes impossible.
Interference, chemical	Results from the various chemical processes that occur during atomization and later the absorption characteristics of the analyte.
Internal Standards	A known amount of standard added to a test portion of a sample as a reference for evaluating and controlling the precision and bias of the applied analytical method.
Intermediate Standard Solution	Reference solutions prepared by dilution of the stock solutions with an appropriate solvent.
International System of Units (SI)	The coherent system of units adopted and recommended by the General Conference on Weights and Measures.
Ion Chromatography (IC)	Instrumentation or process that allows the separation of ions and molecules based on the charge properties of the molecules.
Isomer	One of two or more compounds, radicals, or ions that contain the same number of atoms of the same element but differ in structural arrangement and properties.

Laboratory Control Sample (LCS)	(however named, such as laboratory fortified blank, spiked blank, or QC check sample): A sample matrix, free from the analytes of interest, spiked with verified known amounts of analytes or a material containing known and verified amounts of analytes and taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a reference method. It is generally used to establish intra-laboratory or analyst-specific precision and bias or to evaluate the performance of the total analytical system, including all preparation and analysis steps.
Laboratory Duplicate	Aliquots of a sample taken from the same container under laboratory conditions and processed and analyzed independently.
Laboratory Information Management System (LIMS)	A computer system that is used to maintain all sample information from sample receipt, through preparation and analysis and including sample report generation.
LabTrack	Database used by Pace Analytical to store and track corrective actions and other laboratory issues.
Learning Management System (LMS)	A training database used by Pace Analytical to train their employees. This system is a self-paced system which is capable of tracking all employee training requirements and documentation.
Legal Chain of custody	Procedures employed to record the possession of samples from the time of sampling through the retention time specified by the client or program. These procedures are performed at the special request of the client and include the use of a Chain of custody Form that documents the collection, transport, and receipt of compliance samples by the laboratory. In addition, these protocols document all handling of the samples within the laboratory.
Limit of Detection (LOD)	(TNI) An estimate of the minimum amount of an analyte in a given matrix that an analytical process can reliably detect. (DoD) The smallest amount or concentration of a substance that must be present in a sample in order to be detected at a high level of confidence (99%). At the LOD, the false negative rate is 1%.
Limit of Quantitation (LOQ)	(TNI) The minimum levels, concentrations or quantities of a target variable (e.g. target analyte) that can be reported with a specified degree of confidence. (DoD) The lowest concentration that produces a quantitative result within specified limits of precision and bias. For DoD projects, the LOQ shall be set at or above the concentration of the lowest initial calibration standard.
Laboratory Information Management System (LIMS)	A computer system that is used to maintain all sample information from sample receipt, through preparation and analysis and including sample report generation.
Learning Management System (LMS)	A web-based database used by the laboratories to track and document training activities. The system is administered by the corporate training department and each laboratory's learn centers are maintained by a local administrator.
Lot	A quantity of bulk material of similar composition processed or manufactured at the same time.
Management	Those individuals directly responsible and accountable for planning, implementing, and assessing work.
Management System	System to establish policy and objectives and to achieve those objectives.

Manager (however named)	The individual designated as being responsible for the overall operation, all personnel, and the physical plant of the environmental laboratory. A supervisor may report to the manager. In some cases, the supervisor and the manager may be the same individual.
Matrix	The substrate of a test sample.
Matrix Duplicate	A replicate matrix prepared in the laboratory and analyzed to obtain a measure of precision.
Matrix Spike (MS) (spiked sample or fortified sample)	A sample prepared, taken through all sample preparation and analytical steps of the procedure unless otherwise noted in a referenced method, by adding a known amount of target analyte to a specified amount of sample for which an independent test result of target analyte concentration is available. Matrix spikes are used, for example, to determine the effect of the matrix on a method's recovery efficiency.
Matrix Spike Duplicate (MSD) (spiked sample or fortified sample duplicate)	A second replicate matrix spike prepared in the laboratory and analyzed to obtain a measure of precision of the recovery of each analyte.
Method	A body of procedures and techniques for performing an activity (e.g., sampling, chemical analysis) systematically presented in the order in which they are to be executed.
Method Blank	A sample of a matrix similar to the batch of associated samples (when available) that is free from the analytes of interest and is processed simultaneously with and under the same conditions as samples through all steps of the analytical procedures: and in which no target analytes or interferences are present at concentrations that impact the analytical results for sample analyses.
Method Detection Limit (MDL)	One way to establish a Detection Limit; defined as the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte.
Method of Standard Additions	A set of procedures adding one or more increments of a standard solution to sample aliquots of the same size in order to overcome inherent matrix effects. The procedures encompass the extrapolation back to obtain the sample concentration.
MintMiner	Program used by Pace Analytical to review large amounts of chromatographic data to monitor for errors or data integrity issues.
National Institute of Standards and Technology (NIST)	A federal agency of the US Department of Commerce's Technology Administration that is designed as the United States national metrology institute (or NMI).
National Pollutant Discharge Elimination System (NPDES)	A permit program that controls water pollution by regulating point sources that discharge pollutants into U.S. waters.
Negative Control	Measures taken to ensure that a test, its components, or the environment do not cause undesired effects, or produce incorrect test results.
Nitrogen Phosphorus Detector (NPD)	A detector used in GC analyses that utilizes thermal energy to ionize an analyte. With this detector, nitrogen and phosphorus can be selectively detected with a higher sensitivity than carbon.

Nonconformance	An indication or judgment that a product or service has not met the requirement of the relevant specifications, contract, or regulation; also the state of failing to meet the requirements.
Not Detected (ND)	The result reported for a compound when the detected amount of that compound is less than the method reporting limit.
Performance Audit	The routine comparison of independently obtained qualitative and quantitative measurement system data with routinely obtained data in order to evaluate the proficiency of an analyst or laboratory.
Performance Based Measurement System (PBMS)	An analytical system wherein the data quality needs, mandates or limitations of a program or project are specified and serve as criteria for selecting appropriate test methods to meet those needs in a cost-effective manner.
Photo-ionization Detector (PID)	An ion detector which uses high-energy photons, typically in the ultraviolet range, to break molecules into positively charged ions.
Polychlorinated Biphenyls (PCB)	A class of organic compounds that were used as coolants and insulating fluids for transformers and capacitors. The production of these compounds was banned in the 1970's due to their high toxicity.
Positive Control	Measures taken to ensure that a test and/or its components are working properly and producing correct or expected results from positive test subjects.
Power of Hydrogen (pH)	The measure of acidity or alkalinity of a solution.
Practical Quantitation Limit (PQL)	Another term for a method reporting limit. The lowest reportable concentration of a compound based on parameters set up in an analytical method and the laboratory's ability to reproduce those conditions.
Precision	The degree to which a set of observations or measurements of the same property, obtained under similar conditions, conform to themselves; a data quality indicator. Precision is usually expressed as standard deviation, variance or range, in either absolute or relative terms.
Preservation	Any conditions under which a sample must be kept in order to maintain the chemical and/or biological integrity of the sample.
Proficiency Testing	A means of evaluating a laboratory's performance under controlled conditions relative to a given set of criteria through analysis of unknown samples provided by an external source.
Proficiency Testing Sample	A sample, the composition of which is unknown to the analyst and is provided to test whether the analyst/laboratory can produce analytical results within the specified acceptance criteria.
Protocol	A detailed written procedure for field and/or laboratory operation that must be strictly followed.
Quality Assurance (QA)	(TNI) An integrated system of management activities involving planning, implementation, assessment, reporting and quality improvement to ensure that a process, item, or service is of the type and quality needed and expected by the client. (DoD) An integrated system of activities involving planning, quality control, quality assessment, reporting, and quality improvement to ensure that a product or service meets defined standards of quality with a stated level of confidence.

Quality Assurance Manual (QAM)	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality Assurance Project Plan (QAPP)	A formal document describing the detailed quality control procedures by which the quality requirements defined for the data and decisions pertaining to a specific project are to be achieved.
Quality Control (QC)	The overall system of technical activities that measures the attributes and performance of a process, item, or service against defined standards to verify that they meet the stated requirements established by the customer; operational techniques and activities that are used to fulfill requirements for quality; also the system of activities and checks used to ensure that measurement systems are maintained within prescribed limits, providing protection against "out of control" conditions and ensuring that the results are of acceptable quality.
Quality Control Sample (QCS)	A sample used to assess the performance of all or a portion of the measurement system. One of any number of samples, such as Certified Reference Materials, a quality system matrix fortified by spiking, or actual samples fortified by spiking, intended to demonstrate that a measurement system or activity is in control.
Quality Manual	A document stating the management policies, objectives, principles, organizational structure and authority, responsibilities, accountability, and implementation of an agency, organization, or laboratory, to ensure the quality of its product and the utility of its product to its users.
Quality System	A structured and documented management system describing the policies, objectives, principles, organizational authority, responsibilities, accountability, and implementation plan of an organization for ensuring quality in its work processes, products (items), and services. The quality system provides the framework for planning, implementing, and assessing work performed by the organization and for carrying out required QA and QC.

Quality System Matrix	These matrix definitions are to be used for purposes of batch and quality control requirements: • **Air and Emissions**: Whole gas or vapor samples including those contained in flexible or rigid wall containers and the extracted concentrated analytes of interest from a gas or vapor that are collected with a sorbant tube, impinger solution, filter, or other device • **Aqueous**: Any aqueous sample excluded from the definition of Drinking Water or Saline/Estuarine. Includes surface water, groundwater effluents, and TCLP or other extracts. • **Biological Tissue**: Any sample of a biological origin such as fish tissue, shellfish or plant material. Such samples shall be grouped according to origin • **Chemical Waste**: A product or by-product or an industrial process that results in a matrix not previously defined. • **Drinking Water**: Any aqueous sample that has been designated a potable or potentially potable water source. • **Non-aqueous liquid**: Any organic liquid with <15% settleable solids • **Saline/Estuarine**: Any aqueous sample from an ocean or estuary, or other saltwater source such as the Great Salt Lake. • **Solids**: Includes soils, sediments, sludges, and other matrices with >15% settleable solids.
Quantitation Range	The range of values in a calibration curve between the LOQ and the highest successively analyzed initial calibration standard. The quantitation range lies within the calibration range.
Random Error	The EPA has established that there is a 5% probability that the results obtained for any one analyte will exceed the control limits established for the test due to random error. As the number of compounds measured increases in a given sample, the probability for statistical error also increases.
Raw Data	Any original factual information from a measurement activity or study recorded in a laboratory notebook, worksheets, records, memoranda, notes, or exact copies thereof that are necessary for the reconstruction and evaluation of the report of the activity or study. Raw data may include photography, microfilm or microfiche copies, computer printouts, magnetic media, including dictated observations, and recorded data from automated instruments. If exact copies of raw data have been prepared (e.g., tapes which have been transcribed verbatim, data and verified accurate by signature), the exact copy or exact transcript may be submitted.
Reagent Blank (method reagent blank)	A sample consisting of reagent(s), without the target analyte or sample matrix, introduced into the analytical procedure at the appropriate point and carried through all subsequent steps to determine the contribution of the reagents and of the involved analytical steps.
Reagent Grade	Analytical reagent (AR) grade, ACS reagent grade, and reagent grade are synonymous terms for reagents that conform to the current specifications of the Committee on Analytical Reagents of the American Chemical Society.
Reference Material	A material or substance one or more properties of which are sufficiently well established to be used for the calibration of an apparatus, the assessment of a measurement method, or for assigning values to materials.

Reference Standard	(TNI) Standard used for the calibration of working measurement standards in a given organization or at a given location. (DoD) A standard, generally of the highest metrological quality available at a given location, from which measurements made at that location are derived.
Relative Percent Difference (RPD)	A measure of precision defined as the difference between two measurements divided by the average concentration of the two measurements.
Reporting Limit (RL)	The level at which method, permit, regulatory and customer-specific objectives are met. The reporting limit may never be lower than the Limit of Detection (i.e. statistically determined MDL). Reporting limits are corrected for sample amounts, including the dry weight of solids, unless otherwise specified. There must be a sufficient buffer between the Reporting Limit and the MDL. (DoD) A client-specified lowest concentration value that meets project requirements for quantitative data with known precision and bias for a specific analyte in a specific matrix.
Reporting Limit Verification Standard (or otherwise named)	A standard analyzed at the reporting limit for an analysis to verify the laboratory's ability to report to that level.
Representativeness	A quality element related to the ability to collect a sample reflecting the characteristics of the part of the environment to be assessed. Sample representativeness is dependent on the sampling techniques specified in the project work plan.
Requirement	Denotes a mandatory specification; often designated by the term "shall".
Retention Time	The time between sample injection and the appearance of a solute peak at the detector.
Sample	Portion of material collected for analysis, identified by a single, unique alphanumeric code. A sample may consist of portions in multiple containers, if a single sample is submitted for multiple or repetitive analysis.
Sample Condition Upon Receipt Form (SCURF)	Form used by Pace Analytical sample receiving personnel to document the condition of sample containers upon receipt to the laboratory (used in conjunction with a COC).
Sample Delivery Group (SDG)	A unit within a single project that is used to identify a group of samples for delivery. An SDG is a group of 20 or fewer field samples within a project, received over a period of up to 14 calendar days. Data from all samples in an SDG are reported concurrently.
Sample Receipt Form (SRF)	Letter sent to the client upon login to show the tests requested and pricing.
Sample Tracking	Procedures employed to record the possession of the samples from the time of sampling until analysis, reporting and archiving. These procedures include the use of a Chain of custody Form that documents the collection, transport, and receipt of compliance samples to the laboratory. In addition, access to the laboratory is limited and controlled to protect the integrity of the samples.
Sampling	Activity related to obtaining a representative sample of the object of conformity assessment, according to a procedure.
Selective Ion Monitoring (SIM)	A mode of analysis in mass spectrometry where the detector is set to scan over a very small mass range, typically one mass unit. The narrower the range, the more sensitive the detector.

Selectivity	The ability to analyze, distinguish, and determine a specific analyte or parameter from another component that may be a potential interferent or that may behave similarly to the target analyte or parameter within the measurement system.
Sensitivity	The capability of a method or instrument to discriminate between measurement responses representing different levels (e.g., concentrations) of a variable of interest.
Shall	Denotes a requirement that is mandatory whenever the criterion for conformance with the specification requires that there be no deviation. This does not prohibit the use of alternative approaches or methods for implementing the specification as long as the requirement is fulfilled.
Should	Denotes a guideline or recommendation whenever noncompliance with the specification is permissible.
Signal-to-Noise Ratio	The signal carries information about the analyte, while noise is made up of extraneous information that is unwanted because it degrades the accuracy and precision of an analysis and also places a lower limit on the amount of analyte that can be detected. In most measurements, the average strength of the noise is constant and independent of the magnitude of the signal. Thus, the effect of noise on the relative error of a measurement becomes greater and greater as the quantity being measured (producing the signal) decreases in magnitude.
Spike	A known mass of target analyte added to a blank sample or sub-sample; used to determine recovery efficiency or for other quality control purposes.
Standard (Document)	The document describing the elements of a laboratory accreditation that has been developed and established within the consensus principles of standard setting and meets the approval requirements of standard adoption organizations procedures and policies.
Standard (Chemical)	Standard samples are comprised of a known amount of standard reference material in the matrix undergoing analysis. A standard reference material is a certified reference material produced by US NIST and characterized for absolute content, independent of analytical test method.
Standard Blank (or Reagent Blank)	A calibration standard consisting of the same solvent/reagent matrix used to prepare the calibration standards without the analytes. It is used to construct the calibration curve by establishing instrument background.
Standard Method	A test method issued by an organization generally recognized as competent to do so.
Standard Operating Procedure (SOP)	A written document that details the method for an operation, analysis, or action with thoroughly prescribed techniques and steps. SOPs are officially approved as the methods for performing certain routine or repetitive tasks
Standard Reference Material (SRM)	A certified reference material produced by the US NIST or other equivalent organization and characterized for absolute content, independent of analytical method.
Statement of Qualifications (SOQ)	A document that lists information about a company, typically the qualifications of that company to compete on a bid for services.
Stock Standard	A concentrated reference solution containing one or more analytes prepared in the laboratory using an assayed reference compound or purchased from a reputable commercial source.

Supervisor	The individual(s) designated as being responsible for a particular area or category of scientific analysis. This responsibility includes direct day-to-day supervision of technical employees, supply and instrument adequacy and upkeep, quality assurance/quality control duties and ascertaining that technical employees have the required balance of education, training and experience to perform the required analyses.
Surrogate	A substance with properties that mimic the analyte of interest. It is unlikely to be found in environmental samples and is added to them for quality control purposes.
Systems Audit	An on-site inspection or assessment of a laboratory's quality system.
Target Analytes	Analytes specifically named by a client (also called project-specific analytes).
Technical Director	Individual(s) who has overall responsibility for the technical operation of the environmental testing laboratory.
Test	A technical operation that consists of the determination of one or more characteristics or performance of a given product, material, equipment, organism, physical phenomenon, process or service according to a specified procedure. The result of a test is normally recorded in a document sometimes called a test report or a test certificate.
Test Method	An adoption of a scientific technique for performing a specific measurement as documented in a laboratory SOP or as published by a recognized authority.
Test Methods for Evaluating Solid Waste, Physical/ Chemical (SW-846)	EPA Waste's official compendium of analytical and sampling methods that have been evaluated and approved for use in complying with RCRA regulations.
Total Petroleum Hydrocarbons (TPH)	A term used to denote a large family of several hundred chemical compounds that originate from crude oil. Compounds may include gasoline components, jet fuel, volatile organics, etc.
Toxicity Characteristic Leaching Procedure (TCLP)	A solid sample extraction method for chemical analysis employed as an analytical method to simulate leaching of compounds through a landfill.
Traceability	The ability to trace the history, application, or location of an entity by means of recorded identifications. In a calibration sense, traceability relates measuring equipment to national or international standards, primary standards, basic physical conditions or properties, or reference materials. In a data collection sense, it relates calculations and data generated throughout the project back to the requirements for the quality of the project. (DoD) The property of a result of a measurement whereby it can be related to appropriate standards, generally international or national standards, through an unbroken chain of comparisons.
Training Document	A training resource that provides detailed instructions to execute a specific method or job function.
Trip Blank	This blank sample is used to detect sample contamination from the container and preservative during transport and storage of the sample. A cleaned sample container is filled with laboratory reagent water and the blank is stored, shipped, and analyzed with its associated samples.
Tuning	A check and/or adjustment of instrument performance for mass spectrometry as required by the method.

Ultraviolet Spectrophotometer (UV)	Instrument routinely used in quantitative determination of solutions of transition metal ions and highly conjugated organic compounds.
Uncertainty Measurement	The parameter associated with the result of a measurement that characterized the dispersion of the values that could be reasonably attributed to the measurand (i.e. the concentration of an analyte).
Validation	The confirmation by examination and provision of objective evidence that the particular requirements for a specific intended use are fulfilled.
Verification	Confirmation by examination and objective evidence that specified requirements have been met. (DoD) Note: In connection with the management of measuring equipment, verification provides a means for checking that the deviations between values indicated by a measuring instrument and corresponding known values of a measured quantity are consistently smaller than the maximum allowable error defined in a standard, regulation or specification peculiar to the management of the measuring equipment. The result of verification leads to a decision either to restore in service, to perform adjustment, to repair, to downgrade, or to declare obsolete. In all cases, it is required that a written trace of the verification performed shall be kept on the measuring instrument's individual record.
Whole Effluent Toxicity (WET)	The aggregate toxic effect to aquatic organisms from all pollutants contained in a facility's wastewater (effluent).

11.0. REFERENCES

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- Methods for Non-conventional Pesticides Chemicals Analysis of Industrial and Municipal Wastewater, Test Methods, EPA-440/1-83/079C
- Environmental Measurements Laboratory (EML) Procedures Manual, HASL-300, US DOE, February, 1992.
- Requirements for Quality Control of Analytical Data, HAZWRAP, DOE/HWP-65/R1, July, 1990.
- Requirements for Quality Control of Analytical Data for the Environmental Restoration Program, Martin Marietta, ES/ER/TM-16, December, 1992.
- Quality Assurance Manual for Industrial Hygiene Chemistry, AIHA, 1988
- National Environmental Laboratory Accreditation Conference, Constitution, Bylaws, and Standards. Most recent

- ISO/IEC 17025:2005, General requirements for the competence of testing and calibration laboratories.

- Department of Defense Quality Systems Manual (QSM), version 4.2, October 25, 2010.

12.0. REVISIONS

The PASI Corporate Quality Office files both a paper copy and electronic version of a Microsoft Word document with tracked changes detailing all revisions made to the previous version of the Quality Assurance Manual. This document is available upon request. All revisions are summarized in the table below.

Document Number	Reason for Change	Date
Quality Assurance Manual revision 13.0	Increased font size of entire document. Section 1.7, fifth paragraph: changed length of time Technical Director can be gone before contacting primary authority (from 65 down to 35 days per TNI standard). Section 1.8.2: Reworded definition for Assistant GM to say "all departments". Fixed numbering issue with sub-sections for section 1.8 and used bullet points instead of numbers. Section 1.8.19: revised position title to capture requirement of some labs. Section 1.9: added language to second bullet point regarding LMS. Section 1.9: added bullet point for on-line courses. Section 2.5: added third note per request from GB (in red text). Section 2.6: Added chart of 2-digit codes (laboratory designations) per audit finding from GB laboratory (matches corporate SOPs). Section 2.7.4: added reference for Waste Handling and Management SOT. Section 3.1: added more method agency references. Section 3.4: added reference to Training SOP at end of section. Section 4.1: fixed numbering issue. Removed anonymous phone number and added reference to the Employee Handbook. Section 4.2: added paragraph of Ohio VAP required language (red text). Section 4.3, fifth paragraph: reworded second sentence for clarity. Section 4.3: added paragraphs of Ohio VAP and DoD required language (red text). Section 4.4, first paragraph: added qualifier to end of paragraph that MS limits are used to assess the batch if the MS is used in place of the LCS. Section 4.4: added paragraph of Ohio VAP required language (red text). Section 4.6: added paragraph of Ohio VAP required language (red text). Section 4.7: added paragraph of Ohio VAP required language (red text). Section 4.10: added paragraph of Ohio VAP required language (red text). Section 4.11: added paragraph of DoD required language (red text). Section 5.1, fifth paragraph: changed wording from LAN/WAN to local server (as opposed to hardcopies) and added language about LMS access. Section 5.1.2: added paragraphs of Ohio VAP and DoD required language (red text). Added new section 5.3- Management of Change. Section 6.2.1: added paragraph of Ohio VAP required language (red text). Section 6.3.2: changed NIST thermometer calibration frequency to every 3 years to match current practice. Section 7.3: added comment about Ohio VAP reporting (red text). Section 8.1.2, last sentence: reworded to match current practice. Section 8.1.3, last paragraph: reworded sentences regarding verification of corrective actions. Section 8.3: revised list of Quarterly Quality report items to match the revised SOP. Section 8.4: added last two bullet points and added second line of last paragraph to match ISO language. Section 9.1: changed bullet point items to match CAR SOP. Section 9.2.1: revised language to match SOP. Section 9.2.2: moved language from old 9.2.8 to 9.2.2. Section 9.2.4: added language to data review section.	30Apr2010

Document Number	Reason for Change	Date
	Glossary: Added definitions for analytical uncertainty, audit, bias, field of accreditation, finding, legal COC, matrix duplicate, method, PT sample, sampling, verification (per TNI standard). Glossary: Added definitions for reporting limit verification standard and initial calibration verification per request. Glossary: revised the following definitions to match new TNI language: DOC, LCS, LOD, MS, MSD, preservation, QA, QC, QC sample, raw data, reference standard, SOPs, and traceability. Also revised language within the definition for Quality System Matrix (previously just called Matrix). Glossary: deleted definition for 'detection limit'. Glossary: added definitions from company Acronym form from IT. Glossary: added definitions for LabTrack and MintMiner. Attachment VIII: added more tests to the chart per QM input including a line item for concentrated waste matrix for VOA 8260. General: changed all references to "Director of Quality, Safety, and Training" to "Director of Quality". General: revised document references to SOTs for Waste Handling and Management and Sample Management. Removed corporate org chart from Attachment IIB and will provide this as a separate document to the QMs. In this way, revisions to the corporate org chart will not necessitate a new QAM revision.	
Quality Assurance Manual 14.0	Cover page: moved signatures to cover page; added new form identification box in header. Added names of signatories Section 1.1 edited for clarity Section 1.3: added language to 3rd paragraph regarding compliance with method and client requirements (TNI V1M2, section 4.2). edited for clarity Section 1.4: Added language describing each of the Core Values, including wording from TNI V1M2, section 4.1 into the "Value Employees" line item. Section 1.5 added fourth bullet point Sections 1.6.2, 1.6.2, 1.6.3, 1.6.4 edited for clarity Section 1.7 edited for clarity Section 1.8.4: added bullet point to QM responsibilities pertaining to corrective actions (TNI V1M2, section 4.1.7.1). Section 1.8.4: added bullet point to QM responsibilities pertaining to the QAM (TNI V1M2, section 4.2.8.2). Section 1.9: reworded and reorganized parts of this section to match current practices using the LMS and for clarity. Section 1.10: moved Data Integrity section from Chapter 4 to Chapter 1.edited for clarity. Section 1.11 edited for clarity Sections 2.1, 2.3, 2.4, 2.5, 2.8, 2.9, 2.10 edited for clarity Section 2.5: added additional bullet point regarding qualified data (TNI V1M2, section 5.8.6.g). Section 2.6: added DoD red letter paragraph regarding time of collection (DoD gray box 14). Section 2.7.1: added new second paragraph to discuss storage blanks (DoD gray box 19). Section 2.7.2: reworded 2nd paragraph- temperatures are checked and documented each day of use (TNI V1M2, section 5.5.13.1.d). Section 2.9: added red letter section to the end of this section regarding DoD subcontract labs (DoD gray box 10). Section 2.9: added wording to the end of the fifth paragraph in this section regarding providing copies of subcontract reports to the client (TNI V1M2, section 4.5.5). 3.1 removed A2LA nad NVLAP and added Standard methods Section 3.2, 3.3 edited for clarity Section 3.4: added phrase to first paragraph (TNI V1M4, section 1.6.1). Section 3.4: added language about running DOC if a method had not been	17Feb2011

Document Number	Reason for Change	Date
	run for 12 months (TNI V1M4, section 1.6.2). Also removed language regarding 'work cells' (removed from TNI standard). Section 4.0; new general paragraph added to explain specifics regarding QC samples (TNI V1M2, section 5.9 and DoD gray box 45). Section 4.1, 4.2, 4.3, 4.4, 4.5, 4.6, 4.9, 4.10, 4.12 edited for clarity Section 4.1: added DoD red letter paragraph regarding method blank contamination (DoD gray box D-1). Section 4.1: added new 4th paragraph regarding method blanks (TNI V1M4, section 1.7.3.1.d). Section 4.2: added wording to 5th paragraph regarding exceedance of LCS limits and data qualifiers (TNI V1M4, section 1.7.4.2.a.i and ii). Section 4.3: added red-letter paragraph regarding MS/MSD requirements for DoD (DoD gray boxes D-7 and D-8). Section 4.4: added wording to 2nd paragraph regarding client-specific surrogate criteria (DoD gray box D-12). Section 4.10: removed sentence from 2nd paragraph ('sufficient buffer' was too vague). Section 4.11: adjusted title of section. Section 5.1: added reference to electronic signature policy in Document Mgmt SOP (TNI V1M2, section 4.2.8.4.r). Section 5.1.2: added language to DoD red letter paragraph (DoD gray box 20).edited for clarity Section 6.1: reworded 5th paragraph to compensate for change in TNI language regarding second source standards (TNI V1M4, section 1.7.1.1.d). Added small vial labeling requirement. Added paragraph about minimum requirements for labeling. Section 6.2, 6.2.1, 6.2.2, 6.3, 6.3.5, 6.4, 7.3, 8.1.1, 8.4 edited for clarity Section 6.3: reworded 2nd paragraph- that all measurements are performed on each day if use and documented (TNI V1M2, section 5.5.13.1.d). Section 6.3.1 added "bracketing the range of use" also edited for clarity Section 7.2: added additional red-letter section for DoD data review steps to be added (DoD gray box 44) and added reference to Data Review SOP. Section 7.3: added DoD red letter paragraph regarding the recording of sample prep and analysis time on final reports (DoD gray box 14). Section 7.3: Added extra requirements for final reports when needed for interpretation of results (TNI V1M2, section 5.10). Section 8.4: edited for clarity Section 9.1: added paragraph regarding non-conforming work (TNI V1M2, section 4.9). Section 9.2.1 added login error Section 9.3 edited for clarity Section 11: added DoD QSM version 4.2 as a reference. Glossary: **added definitions** for NIST, reference material, standard (document), selectivity, acceptance criteria, accreditation, accrediting authority, accrediting body, analyst, assessment, atomization, calibration method, calibration range, calibration standard, certified reference material, chain of custody (as opposed to COC form), client (customer), congener, conformance, consensus standard, continuing calibration verification (as opposed to CCV standard), data audit, definitive data, detection limit, digestion, eluent, elute, elution, environmental data, environmental monitoring, homologue, inspection, interference (spectral and chemical), SI, instrument blank, isomer, laboratory duplicate, LOQ (added DoD version), manager, management, management system, matrix, method of standard additions, negative control, nonconformance, performance audit, positive control, quality manual, quantitation range, reagent blank, reference standard (DoD version), reporting limit (DoD version), requirement, retention time, sample, shall, should, signal-to-noise ratio, spike, standard method, standard reference material, supervisor, target analytes, technical	

Document Number	Reason for Change	Date
	director, test, test method, traceability (DoD version), tuning, validation. Glossary: **revised definitions** for standard (chemical), accuracy, aliquot, analyte, batch, calibration, calibration curve, confirmation, corrective action, document control, duplicate, finding, holding time (added DoD version too), LCS, LOD (added DoD version too), MDL (adopted DoD clarification since TNI dropped MDL), precision, PT sample, quality assurance (added DoD version), QAPP, raw data, ICV, verification (added DoD note). Glossary: **removed definition** for calibration verification.	
Quality Manual Revision 14.1	Corrected Table of Content Errors and added QAA job description	25May2011
Quality Manual Revision 14.2	Added DoD Gray Box 37 criteria to the organic CCV in Section 6.2.1 Added DoD Gray Box 18 Data Integrity Officer duties to Quality Manager responsibilities	14Oct2011
Quality Manual Revision 14.3	1.8.4 – added "operate as the designated…" 4.1 – added "method" in front of the word "blank" where appropriate, added "acceptable method blanks…" 6.3.1 – added "prior to use" before "with weights" 7.5 – added "for Ohio VAP labs…" 7.6 – added "for Ohio VAP labs…" Attachment V - updated Added The scope and application certificates are maintained in the filing cabinets in the QA Department. To Attachment VI	26Jan2012

ATTACHMENT I- QUALITY CONTROL CALCULATIONS

PERCENT RECOVERY (%REC)

$$\%REC = \frac{(MSConc - SampleConc)}{TrueValue} * 100$$

NOTE: The SampleConc is zero (0) for theLCS and Surrogate Calculations

PERCENT DIFFERENCE (%D)

$$\%D = \frac{MeasuredValue - TrueValue}{TrueValue} * 100$$

where:
TrueValue = Amount spiked (can also be the $\overline{CF}$ or $\overline{RF}$ of the ICAL Standards)
Measured Value = Amount measured (can also be the CF or RF of the CCV)

PERCENT DRIFT

$$\%Drift = \frac{CalculatedConcentration - TheoreticalConcentration}{TheoreticalConcentrtion} * 100$$

RELATIVE PERCENT DIFFERENCE (RPD)

$$RPD = \frac{|(R1 - R2)|}{(R1 + R2)/2} * 100$$

where:
R1 = Result Sample 1
R2 = Result Sample 2

CORRELATION COEFFICIENT (R)

$$\frac{\sum_{i=1}^{N} W_i * (X_i - \overline{X}) * (Y_i - \overline{Y})}{\sqrt{\left(\sum_{i=1}^{N} W_i * (X_i - \overline{X})^2\right) * \left(\sum_{i=1}^{N} W_i * (Y_i - \overline{Y})^2\right)}}$$

CorrCoeff =

With:

N	Number of standard samples involved in the calibration
i	Index for standard samples
Wi	Weight factor of the standard sample no. i
Xi	X-value of the standard sample no. i
X(bar)	Average value of all x-values
Yi	Y-value of the standard sample no. i
Y(bar)	Average value of all y-values

ATTACHMENT I- QUALITY CONTROL CALCULATIONS (CONTINUED)

STANDARD DEVIATION (S)

$$S = \sqrt{\sum_{i=1}^{n} \frac{(X_i - \overline{X})^2}{(n-1)}}$$

where:
n = number of data points
X_i = individual data point
$\overline{X}$ = average of all data points

AVERAGE ($\overline{X}$)

$$\overline{X} = \frac{\sum_{n=1}^{i} X_i}{n}$$

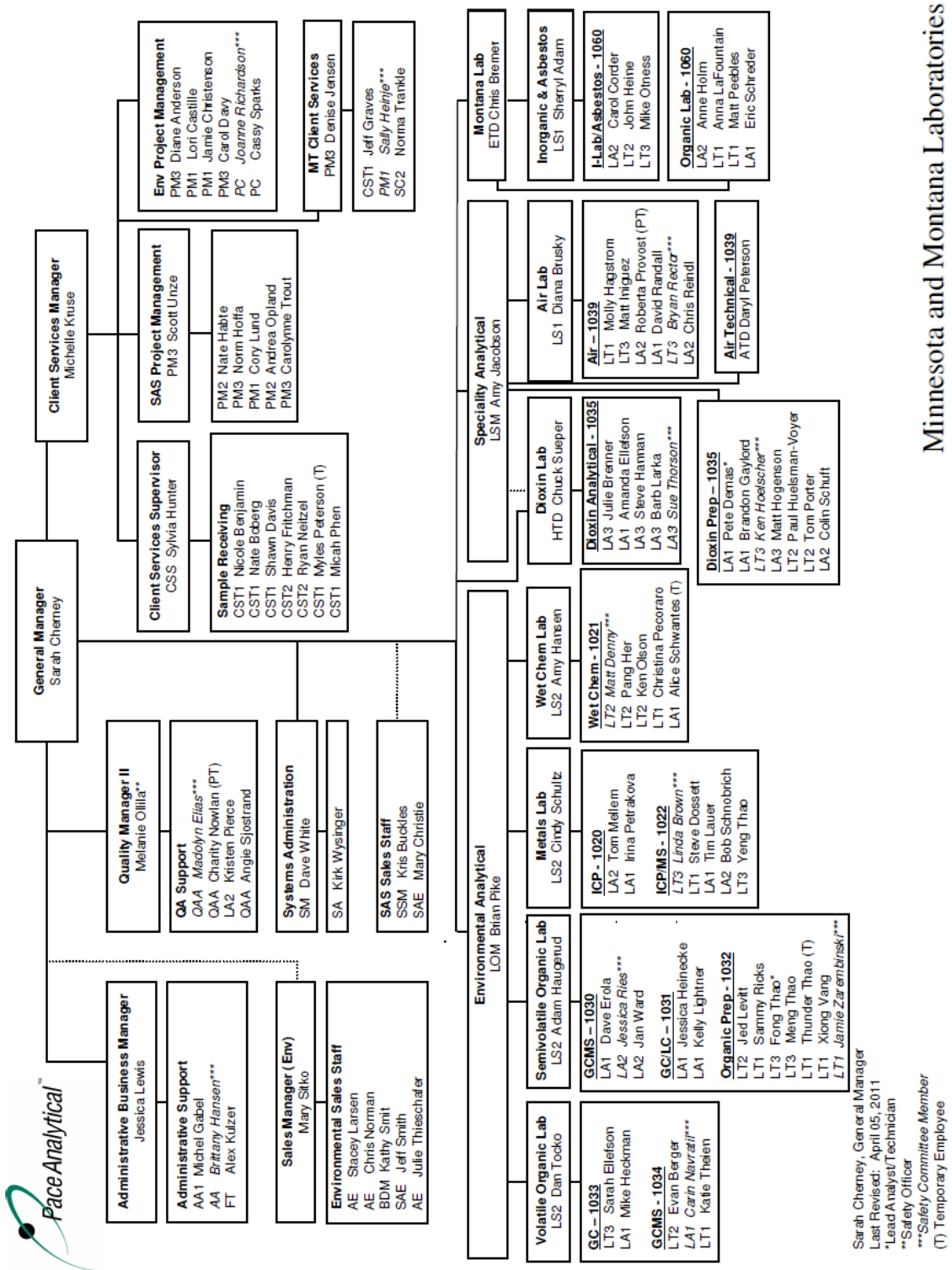
where:
n = number of data points
X_i = individual data point

RELATIVE STANDARD DEVIATION (RSD)

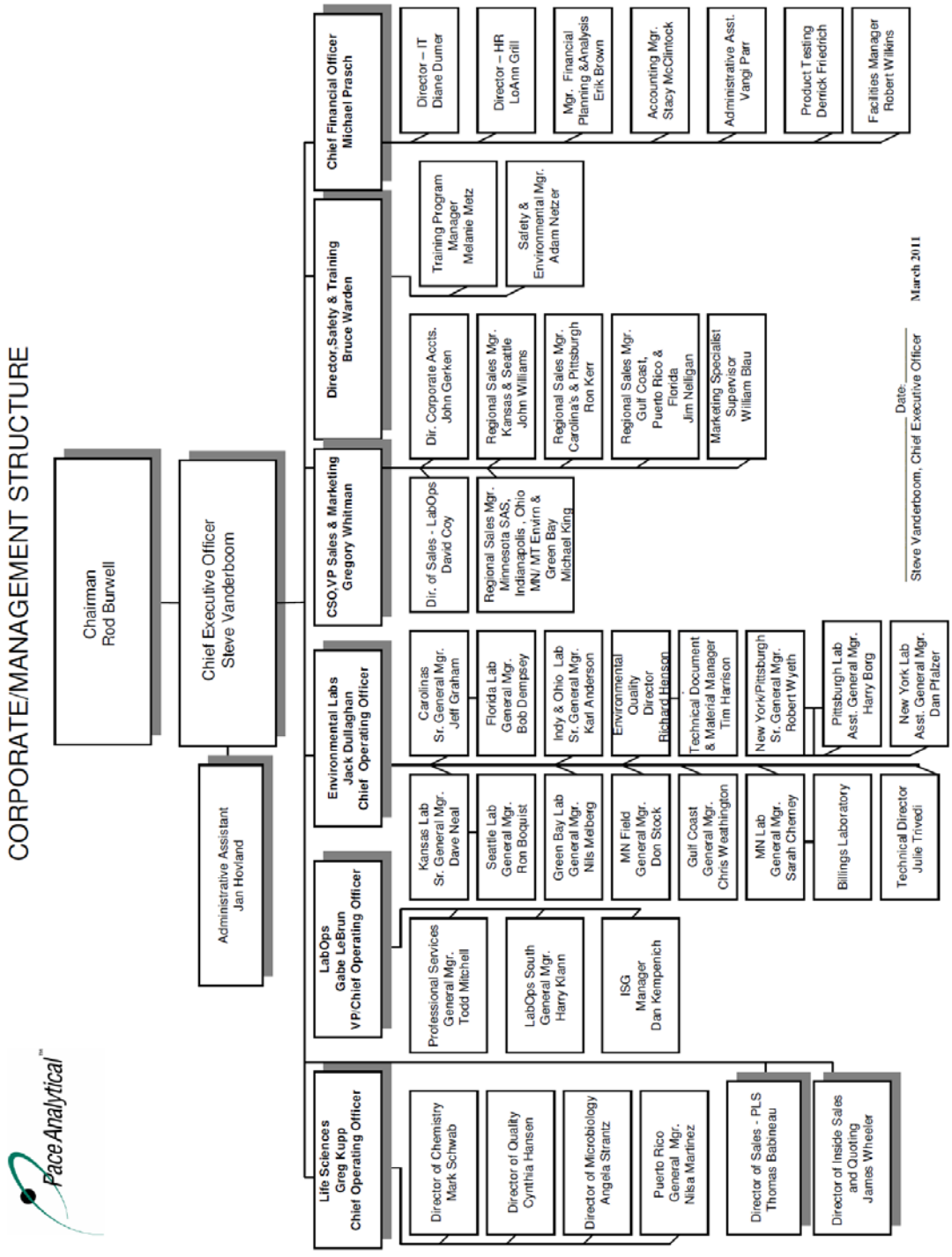
$$RSD = \frac{S}{\overline{X}} * 100$$

where:
S = Standard Deviation of the data points
$\overline{X}$ = average of all data points

ATTACHMENT IIA- LABORATORY ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)



ATTACHMENT IIB- CORPORATE ORGANIZATIONAL CHART (CURRENT AS OF ISSUE DATE)



ATTACHMENT III- EQUIPMENT LIST (CURRENT AS OF ISSUE DATE)

DEPT	INSTRUMENT	ID	MANUFACTURER	MODEL NUMBER	DETECTOR(S)	ANALYSIS
Air	GC	10AIR0	Agilent Technologies	6890N	GC/MS	TO-15
Air	MS	10AIR0	Agilent Technologies	5973 Network	GC/MS	TO-15
Air	Concentrator	10AIR0	Entech Instruments, Inc.	7100A	GC/MS	TO-15
Air	GC	10AIR5	HP	5890	TCD	3C
Air	GC	10AIR7	Agilent Technologies		GC/MS	TO-15
Air	MS	10AIR7	Agilent Technologies		GC/MS	TO-15
Air	Concentrator	10AIR7	Entech Instruments, Inc.	7100A	GC/MS	TO-15
Air	GC	10AIR9	Agilent Technologies	G1530A	GC/FID/TCD	RSK 175
Air	Headspace Sampler	10AIR9	Agilent Technologies	G1888	GC/FID/TCD	RSK 175
Air	GCMS	10AIRA	ALS Ready	6890A	GC	TO3 BTEX
Air	Concentrator	10AIRA	Entech Instruments, Inc.	7100A	GC	TO3 BTEX
Air	MS	10AIRB	Agilent Technologies	5973 inert	GC/MS	TO-15
Air	GC	10AIRB	Agilent Technologies	6890	GC/MS	TO-15
Air	Concentrator	10AIRB	Entech Concentrator	7100A	GC/MS	TO-15
Air	GC	10AIRD	Agilent Technologies	7890A	GC/MS	TO14/15
Air	MS	10AIRD	Agilent Technologies	5975C	GC/MS	TO14/15
Air	Concentrator	10AIRD	Agilent Technologies		GC/MS	TO14/15
Air	Autosampler	10AIRE	Agilent Technologies	7693	GC/MS	TO17
Air	MS	10AIRE	Agilent Technologies	5975C	GC/MS	TO17
Air	GC	10AIRE	Agilent Technologies	7890A	GC/MS	TO17
Air	Thermal Desorber	10AIRE	Perkin Elmer	Turbomatrix 650	GC/MS	TO17
Air	Canister Autosampler	AIR7T1	Entech Instruments, Inc.	7016 CA	NA	TO-15
Air	Canister Autosampler	AIR7T2	Entech Instruments, Inc.	7017 CA	NA	TO-15
Air	Canister Autosampler	AIRBT1	Entech Instruments, Inc.	7018 CA	NA	TO-15
Air	Canister Autosampler	AIRBT2	Entech Instruments, Inc.	7019 CA	NA	TO-15
Air	Canister Autosampler	AIR0T1	Entech Instruments, Inc.	7020 CA	NA	TO-15
Air	Canister Autosampler	AIR0T3	Entech Instruments, Inc.	7021 CA	NA	TO-15
Air	Oven	10AIR10	Despatch	LDB Series	NA	General - AIR
HRMS PREP	Balance	P1885308	A&D	EK4100i	NA	General - DRMS Prep
HRMS PREP	Micro 100 Turbidimeter	10HR10	Scientific Inc.	Micro 100 Turbidimeter	NA	Turbidity
HRMS PREP	Microwave	NA	CEM	MarsXpress	NA	8290/1613 Solid & Wipe, 1668A short list & 209 solid
HRMS PREP	Oven	10HRMS11	Scientific Prod.	DK63	NA	General - HRMS Prep
HRMS PREP	N-EVAP	N-EVAP 1	Organomation	112	NA	General - HRMS Prep
HRMS PREP	N-EVAP	N-EVAP 2	Organomation	112	NA	General - HRMS Prep
HRMS PREP	N-EVAP	N-EVAP 3	Organomation	112	NA	General - HRMS Prep
HRMS	GC/MS	10MSHR09	CTC Analytics	6890N	GC/MS	1613/8290/Mthd 23,29/TO9/DW
HRMS	GC/MS	10MSHR09	Micromass	Autospec Premier	GC/MS	1613/8290/Mthd 23,29/PCB
HRMS	GC/MS	10MSHR06	HP	6890A	GC/MS	1613/8290/Mthd 23,29/1614
HRMS	GC/MS	10MSHR06	Micromass	Autospec Ultima	GC/MS	1613/8290/Mthd 23,29
HRMS	GC/MS	10MSHR10	Thermo Scientific	Trace GC Ultra	GC/MS	1613/8290/Mthd 23,29/DW
HRMS	GC/MS	10MSHR10	Thermo Scientific	Trace GC Ultra	GC/MS	1613/8290/Mthd 23,29/DW
HRMS	GC/MS	10MSHR10	DFS	High Res Magnetic Sector MS	GC/MS	1613/8290/Mthd 23,29/DW
HRMS	GC/MS	10MSHR11	Thermo Scientific	Trace GC Ultra	GC/MS	1613/8290/Mthd 23,29/DW
HRMS	GC/MS	10MSHR11	Thermo Scientific	Trace GC Ultra	GC/MS	1613/8290/Mthd 23,29/DW
HRMS	GC/MS	10MSHR11	DFS	High Res Magnetic Sector MS	GC/MS	1613/8290/Mthd 23,29/DW
HRMS	GC/MS	10MSHR05	Agilent	6890	GC/MS	1613/8290/Mthd 23,29/DW/PCB
HRMS	GC/MS	10MSHR05	Micromass	Autospec Ultima	GC/MS	1613/8290/Mthd 23,29
Metals	Balance	50206779	Sartorius	BP 110 S	NA	General - Metals
Metals	Balance	5306049	AND	FX 3200	NA	General - Metals
Metals	Balance	467	Ohaus	1500 D	NA	General - Metals
Metals	Ion Analyzer	10WET15	Orion	EA 940	NA	pH
Metals	Turbidimeter	10WET10	Scienific Inc	Micro 100 Turbidimeter	NA	Turbidity
Metals	ICPMS	10ICM03	Thermo Scientific	Xseries 2	MS	Metals
Metals	ICPMS	10ICM02	Perkin Elmer Sciex	Elan 9000	MS	Metals
Metals	ICPMS	10ICM4	Thermo Scientific	XII	MS	Metals
Metals	ICP	10ICP03	Perkin Elmer Instruments	Optima 4300 DV	SCCD	Metals
Metals	ICP	10ICP02	Perkin Elmer Instruments	Optima 4300 DV	SCCD	Metals
Metals	Tumbler	10MET06	Associated Design & Mfg. Co.	3740-24BRE	NA	TCLP Prep
Metals	Hot Block	10MET01	Environmental Express	NA	NA	6010/Mercury/6020/200.8/Mthd 29
Metals	Hot Block	10MET02	Environmental Express	NA	NA	6010/Mercury/6020/200.8/Mthd 29
Metals	Hot Block	10MET03	Environmental Express	NA	NA	6010/Mercury/6020/200.8/Mthd 29
Metals	Hot Block	10MET04	Environmental Express	NA	NA	6010/Mercury/6020/200.8/Mthd 29
Metals	Hot Block	10MET05	Thomas Cain Inc.	Deena 60	NA	Metals Prep
Metals	Sonicator	10MET07	Fisher Scientific	FS20D	NA	Cleaning glassware
Metals	Stir Plate	10MET19	Barnstead/Thermolyne	Super-Nuova	NA	General - Metals
Metals	Hot Plate	10MET18	Thermolyne	Cimarec 3	NA	General - Metals
Metals	Mercury Analyzer	10HG3	Cetac Quick Trace	M-7500	NA	Mercury
Metals	Mercury Autosampler	10HG3	ASX-520	MAS Ver w/Diluter	NA	Mercury
O-Prep	Balance	8200351	AND	FX-2000	NA	General - O-prep
O-Prep	Balance	25455076	Denver Inst	MXX-612	NA	General - O-prep
O-Prep	Muffle Furnace	10WET21	Fischer Scientific	Isotemp Muffle Furnace	NA	General - O-prep
O-Prep	UltraSonicator	10OP12	Branson	8510	NA	General - O-prep
O-Prep	Sonicator	10OP01	Masonix	XL 2020	NA	3550
O-Prep	Sonicator	10OP02	Masonix	XL 2015	NA	3550

ATTACHMENT III- EQUIPMENT LIST (CONTINUED)

DEPT	INSTRUMENT	ID	MANUFACTURER	MODEL NUMBER	DETECTOR(S)	ANALYSIS
O-Prep	Sonicator	10OP03	Masonix	Sonicator 3000	NA	3550
O-Prep	Sonicator	10OP04	Masonix	Sonicator 3000	NA	3550
O-Prep	Soxtherm	10OP06	Gerhardt	NA	NA	8082
O-Prep	Soxtherm	10OP07	Gerhardt	NA	NA	8082
O-Prep	Soxtherm	10OP08	Gerhardt	NA	NA	8082
O-Prep	Soxtherm	10OP09	Gerhardt	NA	NA	8082
O-Prep	N-EVAP	10OP10	Organomation	112	NA	General - O-prep
O-Prep	N-EVAP	10OP11	Organomation	112	NA	General - O-prep
O-Prep	Centrifuge	10OP13	IEC	Centra GP8	NA	General - O-prep
O-Prep	Centrifuge	10OP14	Damon/IEC Division	NA	NA	General - O-prep
O-Prep	Centrifuge	10OP15	International Clinical Centrifuge	CL28899M	NA	General - O-prep
SVOA	Balance	H47315	Mettler	AE 200	NA	General - SVOA
SVOA	GCMS	10MSSA	Agilent	7890A	MS	TO13, CPAH
SVOA	GCMS	10MSSA	High Volume Injector		MS	TO13, CPAH
SVOA	Mass Spec	10MSS03	HP	5973	MS	CPAH, PCP
SVOA	GC	10MSS03	HP	6890	MS	CPAH, PCP
SVOA	Agilent Tray	10MSS03	Agilent	N 10149	MS	CPAH, PCP
SVOA	Injector Tower	10MSS03	Agilent	7683	MS	CPAH, PCP
SVOA	MS Detector	10MSS06	Agilent	6890N	MS	SIM, PCP
SVOA	MS Detector	10MSS07	Agilent	6890	MS	8280
SVOA	AutoSampler Tower	10MSS08	Agilent	7683	MS	Sulfolane, 8270, 625
SVOA	GC/Oven	10MSS08	Agilent	6890N	MS	Sulfolane, 8270, 625
SVOA	MS Detector	10MSS08	Agilent	5973N	MS	Sulfolane, 8270, 625
SVOA	AutoSampler Tray	10MSS08	Agilent	7683	MS	Sulfolane, 8270, 625
SVOA	GC/Oven	10MSS09	Agilent	6890A	MS	8270, 625
SVOA	AutoSampler Tower	10MSS09	Agilent	18593B	MS	8270, 625
SVOA	MS Detector	10MSS09	Agilent	5973N	MS	8270, 625
SVOA	AutoSampler Tray	10MSS09	Agilent	18596C	MS	8270, 625
SVOA	GC Oven	10GCS04	HP	5890	Dual FID	AK, NWTPH
SVOA	AutoSampler /Tower	10GCS04	HP	7673A	Dual FID	AK, NWTPH
SVOA	GC Oven	10GCS05	HP	5890 SII	Dual FID	CALDRO, WIDRO
SVOA	AutoSampler Tray	10GCS05	HP	18596B	Dual FID	CALDRO, WIDRO
SVOA	AutoSampler Tower	10GCS05	HP	7673	Dual FID	CALDRO, WIDRO
SVOA	GC	10GCS07	Agilent	6890N	Dual ECD	PCB, TO4
SVOA	AutoSampler Tray	10GCS07	Agilent	G2614A	Dual ECD	PCB, TO4
SVOA	Tower	10GCS07	HP	N279	Dual ECD	PCB, TO4
SVOA	GC Oven	10GCS08	Agilent	6890N	Dual FID	CALDRO, WIDRO
SVOA	AutoSampler	10GCS08	Agilent	7683	Dual FID	CALDRO, WIDRO
SVOA	Tower	10GCS08	Agilent	7683	Dual FID	CALDRO, WIDRO
SVOA	GC	10GCS09	Agilent		Dual FID	DRO
SVOA	GCMS	10MSSB	Agilent	7863B	MS	SIM, TO13, High Volume Injection
SVOA	GCMS	10MSSB	Agilent	7890	MS	SIM, TO13, High Volume Injection
SVOA	GCMS	10MSSB	Agilent	5975C	MS	SIM, TO13, High Volume Injection
SVOA	GCMS	10MSSB	Agilent	7863	MS	SIM, TO13, High Volume Injection
SVOA	Oven	10WET49	Fisher Scientific	NA	NA	% Moisture
SVOA	Oven	10WET50	Baxter DS-64	DS-64	NA	% Moisture
VOA	Balance	21353507	Denver Inst	MXX-212	NA	General - VOA
VOA	Balance	5304905	AND	FX-3200	NA	General - VOA
VOA	AutoSampler	10MSV1	Environmental Sample Tech, Inc.	NA	NA	UST, BTEX
VOA	Concentrator	10MSV1	Tekmar	3000	MS	UST, BTEX
VOA	GC System	10MSV1	HP	6890	GC	UST, BTEX
VOA	MS Detector	10MSV1	HP	5973	MS	UST, BTEX
VOA	AutoSampler	10MSV3	O-I-Analytical	4552	NA	8260 Med. Lvl Soil
VOA	Concentrator	10MSV3	Tekmar	3100	MS	8260 Med. Lvl Soil
VOA	GC System	10MSV3	Agilent	6890	GC	8260 Med. Lvl Soil
VOA	MS Detector	10MSV3	Agilent	5973	MS	8260 Med. Lvl Soil
VOA	AutoSampler	10MSV5	Varian Archon	NA	NA	8260/624/TCLP/UST
VOA	Concentrator	10MSV5	Tekmar Dohrmann	3100	MS	8260/624/TCLP/UST
VOA	GC System	10MSV5	HP	6890	GC	8260/624/TCLP/UST
VOA	MS Detector	10MSV5	HP MS	5973	MS	8260/624/TCLP/UST
VOA	AutoSampler	10MSV6	Varian Archon	NA	NA	524/8260/624
VOA	Concentrator	10MSV6	Tekmar	3000	MS	524/8260/624
VOA	GC System	10MSV6	Agilent	6890A	GC	524/8260/624
VOA	MS Detector	10MSV6	Agilent	5973	MS	524/8260/624
VOA	AutoSampler	10MSV7	Environmental Sample Tech, Inc.	NA	NA	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	GC System	10MSV7	Agilent Technologies	6850	MS	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	Concentrator	10MSV7	Tekmar	3000	GC	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	MS Detector	10MSV7	Agilent Technologies	5975C	MS	SIM/8260/624/Low & Med Lvl Soil/TCLP/UST
VOA	GC/MS	10MSV8	Agilent Technologies	5975C	GC/MS	8260/624/TCLP/UST
VOA	AutoSampler	10MSV8	Environmental Sample Tech, Inc.	Centurion	NA	8260/624/TCLP/UST
VOA	Concentrator	10MSV8	Encon Ev	NA	NA	8260/624/TCLP/UST
VOA	AutoSampler	10GCV1	Varian Archon	NA	NA	8021/8015/GRO
VOA	Concentrator	10GCV1	Tekmar Dohrmann	3100	NA	8021/8015/GRO
VOA	GC System	10GCV1	HP	5890	PID/FID	8021/8015/GRO

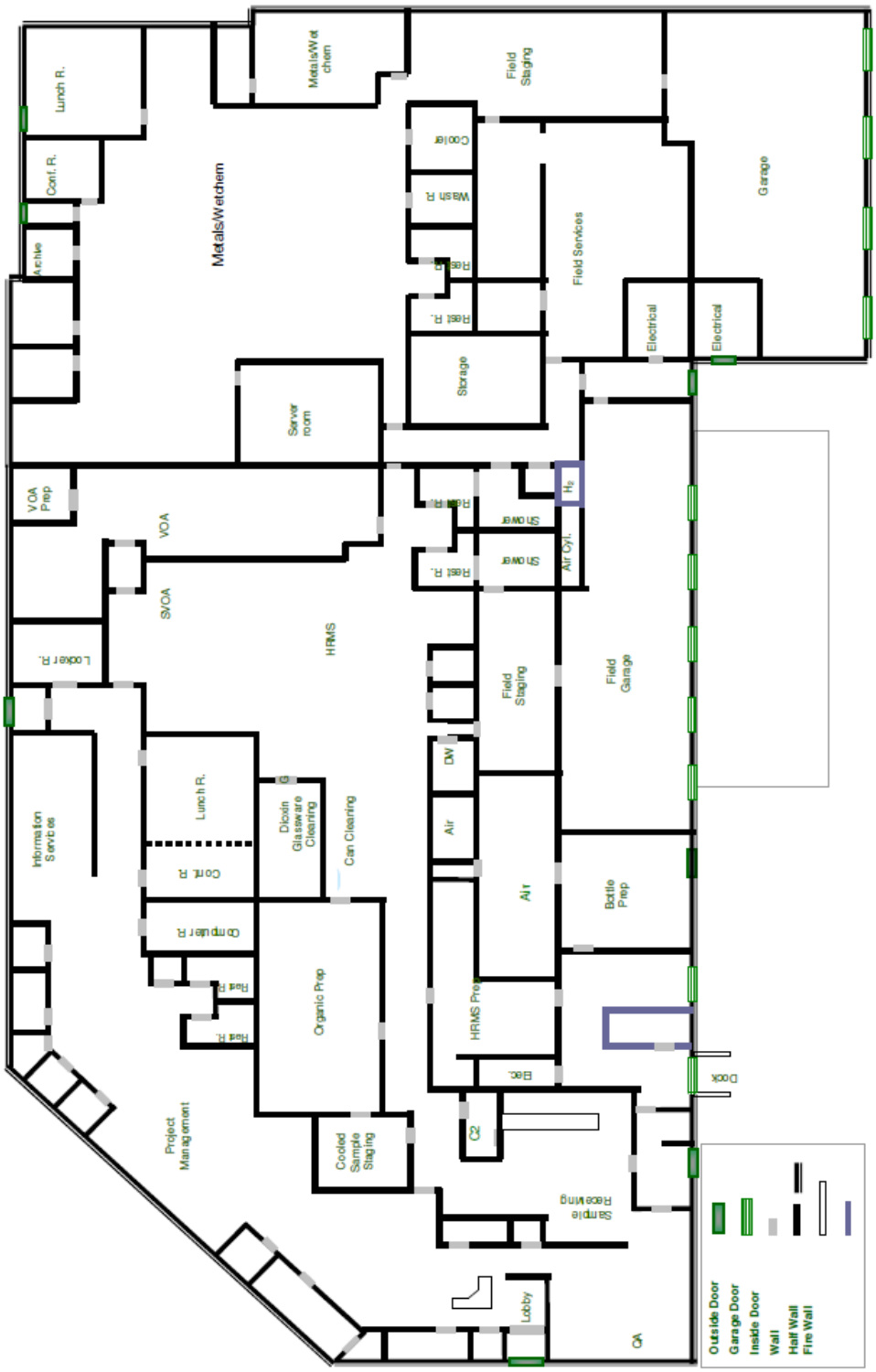
ATTACHMENT III- EQUIPMENT LIST (CONTINUED)

DEPT	INSTRUMENT	ID	MANUFACTURER	MODEL NUMBER	DETECTOR(S)	ANALYSIS
VOA	AutoSampler	10GCV3	Environmental Sample Tech, Inc.	NA	NA	8021/8015/GRO
VOA	Concentrator	10GCV3	Tekmar Dohrmann	3100	NA	8021/8015/GRO
VOA	GC system	10GCV3	HP	5890 Series II	PID/FID	8021/8015/GRO
VOA	AutoSampler	10GCV5	Varian Archon		NA	8021/8015/GRO
VOA	Concentrator	10GCV5	Tekmar	3000	NA	8021/8015/GRO
VOA	GC system	10GCV5	HP	G1530A	PID/FID	8021/8015/GRO
VOA	Oven	10VOA03	Thermo Scientific	NA	NA	General - VOA
VOA	Sonicator	10VOA04	Fisher Scientific	FS220	NA	8260/8021/8015/GRO
Wet Chem	Balance	10406293	Sartorius	AC 210 S	NA	General - Wet Chem
Wet Chem	Balance	7123180939	Ohaus	Scout Pro	NA	General - Wet Chem
Wet Chem	Balance	30208225	Sartorius	AC 210 S	NA	General - Wet Chem
Wet Chem	Balance	1125521193	Mettler-Toledo	AB135-S	NA	General - Wet Chem
Wet Chem	Incubator	10WET16	Fisher Scientific	Isotemp Incubator	NA	BOD
Wet Chem	Incubator	10WET22	Fisher Scientific	307	NA	BOD
Wet Chem	Incubator	10WET35	Fisher Scientific	307C	NA	BOD
Wet Chem	Autotitrator	10WET6	Metrohm	888 Titrando Titrator		Alkalinity
Wet Chem	Autosampler	10WET6	Metrohm	778 Sample Processor	NA	Alkalinity
Wet Chem	Diss. Oxy Meter	10WET51	YSI	5000	NA	BOD
Wet Chem	Oven	10WET17	Precision Scientific	130 DM	NA	General - Wet Chem
Wet Chem	Oven	10WET20	Fisher Scientific	Isotemp Oven	NA	General - Wet Chem
Wet Chem	Oven	10WET19	VWR Scientific	1370F	NA	General - Wet Chem
Wet Chem	AutoClave	10WET29	Harvey	NA	NA	General - Wet Chem
Wet Chem	pH Meter	10WET7	Orion	NA	NA	pH
Wet Chem	pH Meter	10WET31	IQ Scientific Instruments	NA	NA	pH
Wet Chem	Explandable Ion Analyzer	10WET8	Orion	EA 940	Ions	Chlorides
Wet Chem	Thermoreactor	10WET26	Neutec Group Inc.	ECO 25	NA	COD
Wet Chem	COD Reactor	10WET11	Bioscience, Inc.	NA	NA	COD
Wet Chem	Microwave	10WET28	GE	JES1142WD04	NA	HPC Auger
Wet Chem	KoneLab	10WET3	Thermo Fisher Scientific	Konelab 20	NA	Colormetric
Wet Chem	Conductivity meter	10WET9	Oaktom	Con 110 Series	NA	Specific Conductivity
Wet Chem	Colony Counter	10WET30	Gallenkamp	Colony Counter	NA	HPC
Wet Chem	Colony Counter	10WET38	Darkfield Quebec	Colony Counter	NA	HPC
Wet Chem	Water Bath	10WET27	Fisher Scientific	Isotemp 210	NA	General - Wet Chem
Wet Chem	Digestion Block	10WET12	Environmental Express	NA	NA	
Wet Chem	Digestion Block	10WET13	MIDI-STIL	NA	NA	
Wet Chem	Spectrometer	10WET32	Hach	DR 2700	NA	COD
Wet Chem	Hot Plate	10WET33	Presto		NA	General - Wet Chem
Wet Chem	Hot Plate	10WET34	Presto	Tilt'n Drain Big Griddle	NA	General - Wet Chem
Wet Chem	Smart Chem	10WT36	West Co Scientific Instruments	Smart Chem 200	NA	Colormetric
Wet Chem	Stir Plate	10WET39	Corning Stirrer	NA	NA	General - Wet Chem
Wet Chem	Hot Plate	10WET40	Corning	NA	NA	General - Wet Chem
Wet Chem	Stir Plate	10WET41	Fisher Scientific	NA	NA	General - Wet Chem
Wet Chem	Stir Plate	10WET42	Thermolyne	Cimarec 2	NA	General - Wet Chem
Wet Chem	Stir Plate	10WET43	Fisher Scientific	NA	NA	General - Wet Chem
Wet Chem	Vortex Mixer	10WET44	American Scientific Prod.	S8223-1	NA	General - Wet Chem
Wet Chem	Extractor	10WET45	Horizon Technology	Spe-dex 4790	NA	Oil & Grease
Wet Chem	Extractor	10WET46	Horizon Technology	Spe-dex 4791	NA	Oil & Grease
Wet Chem	Extractor	10WET47	Horizon Technology	Spe-dex 4792	NA	Oil & Grease
Wet Chem	Extractor	10WET48	Horizon Technology	Spe-dex 4793	NA	Oil & Grease
Wet Chem	Closed Cup - Penske	10WT49	Precision Scientific	NA	NA	Flashpoint
Wet Chem	Hot Plate	10MET18	Thermolyne	Cimarec 3	NA	General - Wet Chem
Wet Chem	IC - autosampler	10WT52	Dionex	AS50	Conductivity	Fl, Cl, Nitrite, Nitrate, Sulfate EPA Method 300.0
Wet Chem	IC - oven	10WT52	Dionex	LC25	Conductivity	Fl, Cl, Nitrite, Nitrate, Sulfate EPA Method 300.0
Wet Chem	IC - conductivity detector	10WT52	Dionex	CD20	Conductivity	Fl, Cl, Nitrite, Nitrate, Sulfate EPA Method 300.0
Wet Chem	IC - gradient pump	10WT52	Dionex	GP50	Conductivity	Fl, Cl, Nitrite, Nitrate, Sulfate EPA Method 300.0
Montana	Balance	14138	Fischer	7227DA	NA	General - Montana
Montana	Balance	E86392	Mettler	AE100	NA	General - Montana
Montana	Balance	24353410	Denver	MXX-212	NA	General - Montana
Montana	Balance	B027060	Fischer	A200DS	NA	General - Montana
Montana	Balance	G325/202300491	Ohaus	Adventuer	NA	General - Montana
Montana	SVOA GC	11MT03	Hewlett-Packard	5890A	FID/PID	EPH
Montana	Autosampler	11MT03	Hewlett-Packard	7673	NA	EPH
Montana	Autosampler	11MT03	Hewlett-Packard	7673	NA	EPH
Montana	SVOA GC	11MT04	Hewlett-Packard	5890	FID/PID	EPH
Montana	Autosampler	11MT04	Hewlett-Packard	7673	NA	EPH
Montana	Autosampler	11MT04	Hewlett-Packard	7673	NA	EPH
Montana	Ion Chromatograph	11MT05	Dionex	ICS1000	NA	EPA Method 300.0
Montana	IC Autosampler	11MT05	Dionex	AS40-1	NA	EPA Method 300.0
Montana	Autoanalyzer Detector	11MT06	Astoria Pacific	305A	Wavelength	N+N, NH3, TKN
Montana	Autoanalyzer Photometer	11MT06	Astoria Pacific	350	NA	N+N, NH3, TKN
Montana	Autoanalyzer Power Supply	11MT06	Astoria Pacific	304A	NA	N+N, NH3, TKN
Montana	Autoanalyzer Heater Unit	11MT06	Astoria Pacific	303A	NA	N+N, NH3, TKN
Montana	Autoanalyzer Autosampler	11MT06	Astoria Pacific	311	NA	N+N, NH3, TKN

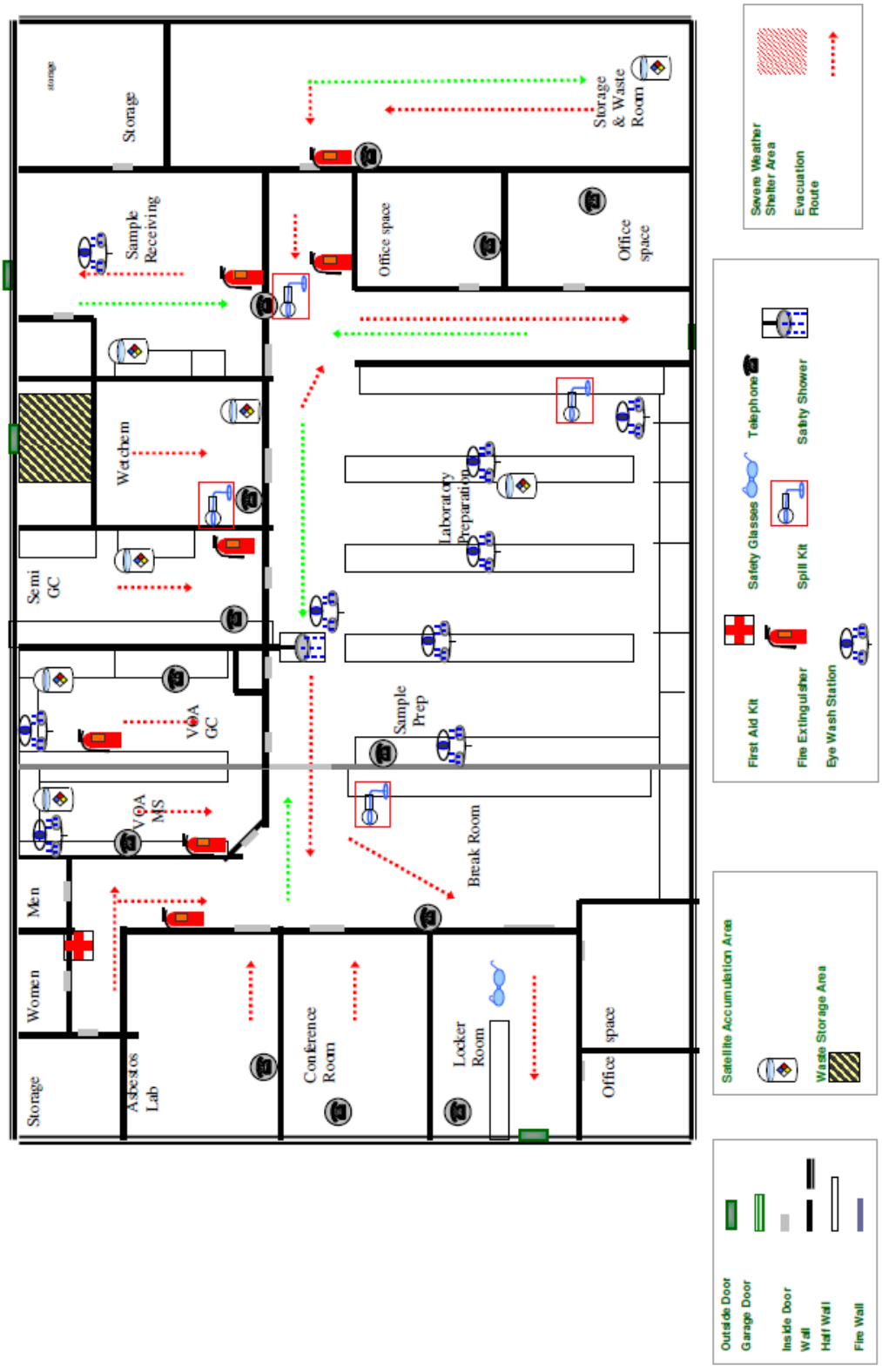
ATTACHMENT III- EQUIPMENT LIST (CONTINUED)

DEPT	INSTRUMENT	ID	MANUFACTURER	MODEL NUMBER	DETECTOR(S)	ANALYSIS
Montana	Autosampler pump	11MT06	Perstorp	502	NA	N+N, NH3, TKN
Montana	Autosampler power supply	11MT06	Perstorp	509	NA	N+N, NH3, TKN
Montana	VOA glassware oven	11MT07	Sargent Welch		NA	General - Montana
Montana	Spectrophotometer	11MT08	Thermo	Aquamate	NA	Cr VI, N02, Tphos, Ophos
Montana	Oven	11MT10	Fischer	Isotemp 255D	NA	General - Montana
Montana	Oven	11MT11	Fischer	Isotemp 630F	NA	General - Montana
Montana	Muffle Furnace	11MT12	Sybron	Thermolyne	NA	General - Montana
Montana	Concentrator	11MT13	Zymark	TurboVap II	NA	Oprep
Montana	Concentrator	11MT14	Zymark	TurboVap II	NA	Oprep
Montana	Concentrator	11MT28	Zymark	Turbo Vap II	NA	Oprep
Montana	Furnace	11MT15	Sybron Thermolyne	1300	NA	General - Montana
Montana	Evaporator	11MT16	Organomation	N-Evap 112	NA	Fractions
Montana	Waterbath	11MT17	Northwest Fixtures		NA	General - Montana
Montana	pH meter	11MT18	Fischer	AR50	NA	pH
Montana	Sonicator	11MT19	Fischer	FS60	NA	General - Montana
Montana	Centrifuge	11MT20	Fischer	Centific	NA	General - Montana
Montana	Oven	11MT21	Despatch	288A	NA	General - Montana
Montana	Furnace	11MT22	Leco	S-144DR	NA	General - Montana
Montana	Turbidimeter	11MT23	HF Scientific	Micro 1000	NA	Turbidity
Montana	Sonicator	11MT24	Heat Systems	Sonicator XL	NA	General - Montana
Montana	Sonicator	11MT25	Branson	Sonfier 450	NA	General - Montana
Montana	Acetone Vaporizer	11MT26	Energy Technology	NA	NA	
Montana	VPH GC	11MT27	Hewlett-Packard	5890	PID/FID	VPH
Montana	Sample Concentrator	11MT27	Tekmar	3100	NA	VPH
Montana	Autosampler	11MT27	Varion	Archon	NA	VPH
Montana	VOA GC	11MT33	Aglient	6890	FID/PID	VPH
Montana	Sample Concentrator	11MT33	Tekmar/Dohrmann	Tekmar 3000	FID/PID	VPH
Montana	Autosampler	11MT33	OI analytical	Archon	NA	VPH
Montana	Microscope	11MT28	Olympus	BH-2	NA	Asbestos
Montana	Vacuum Pump		Edwards	E2M2	NA	
Montana	Microscope	11MT32	Olympus	BH-2	NA	Asbestos
Montana	Microscope	11MT29	Olympus	BH-2	NA	Asbestos
Montana	Stereoscope	11MT30	Fischer	NA	NA	Asbestos
Montana	Microscope	11MT31	Olympus	G10X	NA	Asbestos
Montana	Block Digestor	11MT34	Lachat	BD-46	NA	TKN
Montana	Oven	11MT35	Precision	NA	NA	General - Drying oven
Montana	AutoSampler	11MT38	O-I-Analytical	4552	NA	8260
Montana	Concentrator	11MT38	Tekmar Dohrmann	3100	NA	8260
Montana	GC System	11MT38	Agilent	6890	GC	8260
Montana	MS Detector	11MT38	Agilent	5973	MS	8260

ATTACHMENT IV- LABORATORY FLOOR PLAN (CURRENT AS OF ISSUE DATE)



ATTACHMENT IV – CONT. MONTANA FACILITY



ATTACHMENT V- LABORATORY SOP LIST (CURRENT AS OF ISSUE DATE)

Determination of Methane, Ethane, and Ethene in Air Modified TO-3	S-MN-A-002
Analysis of Air Samples for Volatile Organic Compounds by Gas Chromatography/PID-FID method TO-3	S-MN-A-003
Cleaning, Certification, Leak Checking and Preparation for Shipment of SUMMA Passivated Canisters	S-MN-A-004
Determination of Fixed Gases in Air by Modified 3C	S-MN-A-005
Methane, Ethane, Ethene, and Propane in Water by GCFID mod. 3810 and RSK 175	S-MN-A-007
Analysis of Whole Air Sample for Volatile Organic Compound by GC/MS EPA TO15/TO14	S-MN-A-013
Determination of Hydrocarbons in Air using Radiello Passive Sample Tubes	S-MN-A-017
Analysis of TO17 Active Air Samples	S-MN-A-018
Sample Management	S-MN-C-001
Bottle Preparatation	S-MN-C-003
Subcontracting Samples	S-MN-C-004
Internal Chain of Custody	S-MN-C-005
The Determination of Specific Aromatic Compounds and Gasoline Range Organic in Water and Soils	S-MN-O-427
Purgeable Total Petroleum Hydrocarbons in Water (8015 Mod / CA LUFT)	S-MN-O-525
Purgeable Total Petroleum Hydrocarbons in Water (NWTPH)	S-MN-O-555
Determination of Gasoline Range Organices by Method AK101	S-MN-O-556
Volatiles Sample Compositing Procedure	S-MN-O-541
Analysis of Volatile Petroleum Hydrocarbons (VPH)	S-MN-O-575
Analysis of Polychlorinated Biphenyls in Oil, Soil, Water, Wipe and Air Matrixes	S-MN-O-432
Determination of Diesel Range Organics in Water and Soil (Wisconsin modified DRO)	S-MN-O-466
Determination of Diesel Range Organics In Water & Soil SW8015 (Modified)	S-MN-O-489
Ethylene glycol, Propylene Glycol, Triethylene Glycol by Modified 8015	S-MN-O-533
The Determination of Extractable Petroleum Hydrocarbons by Method NwTPH-Dx	S-MN-O-553
The Determination of Diesel Range Organics and Residual Range Organics by AK102-AK103	S-MN-O-554
Saturated Hydrocarbons (Alkanes/Isoprenoids Compounds) and Total Extractable Hydrocarbons	S-MN-O-567
Preparation and Analysis of Samples for the Determination of Dioxins and Furans by USEPA Method 8290	S-MN-H-001
Preparation and Analysis of Samples for the Determination of Dioxins and Furans using USEPA Method 1613B	S-MN-H-002
Preparation and Analysis of Samples for the Determination of 2,3,7,8-TCDD using USEPA Method 1613B, Drinking Water	S-MN-H-003
Percent Lipids Determination	S-MN-H-004
Preparation and Analysis of Samples for the Determination of PCDDs, PCDFs, and PCBs by modified USEPA Method 23, TO9, or NY State Guidelines	S-MN-H-005
Preparation and Analysis of Samples for the Determination of Dioxins and Furans by USEPA Method 8280A	S-MN-H-007
Method 1668, PCB Congenger (WHO List)	S-MN-H-009
Preparation and Analysis of Samples for the Determination of Chlorinated Biphenyl Congeners by USEPA Method 1668A	S-MN-H-014
Preparation and Analysis of Samples for the Determination of Polybrominated Diphenyl Ether Congeners	S-MN-H-016
Preparation and Analysis of Samples for the Determination of Dioxins and Furans by USEPA Method 8290A	S-MN-H-019
Preparation and Analysis of Samples for the Determination of Dioxin and Furans by USEPA Method DLM2.0	S-MN-H-021
Preparation and Analysis of Samples for the Determination of Chlorinated Biphenyl Congeners	S-MN-H-022
Operation and Maintenance of the Perkin Elmer ELAN 9000 ICP-MS	S-MN-I-525
TCLP/SPLP	S-MN-I-312
Inductively Coupled Plasma Atomic Emission Spectroscopy (RCRA)	S-MN-I-313
Hardness by Calculation	S-MN-I-338
Mercury im Liquid and Solid/Semis-Solid Waste	S-MN-I-359
Digest Procedure for Aqueous Samples to be Analyzed by Induct Coupled Plasma (SW-846)	S-MN-I-458
Metals Preparation for Solid samples, Wipes and Filters	S-MN-I-460
Metals Analysis by ICP/MS - Method 6020 and 200.8	S-MN-I-492
Mercury in End Caps and Glass Samples	S-MN-I-517
Preparation of Aqueous Samples for ICPMS Analysis by Method 3030C	S-MN-I-523
Operation of the DEENA automated Prep System	S-MN-I-531
Mercury in Solid Waste by CLP	S-MN-I-557
Operation and Maintenance of the Perkin Elmer Optima 4300 ICP	S-MN-I-567
Operation and Maintenance of the Thermo ICPMS	S-MN-I-578
Operation and Maintenance of the CETAC M-7500 Analyzer	S-MN-I-580
Extractable Base/Neutral and Acid Organic Compounds in Liquid, Solid, and TCLP Matrices by Gas Chromatography/Mass Spectrometry Capillary Column Technique	S-MN-O-436
8270-L Extractable Base/Neutral and Acid Organic Compounds in Water and Liquid Matrices by GC/MS Capillary Column Technique w/Selective Ion Monitoring	S-MN-O-507

ATTACHMENT V- LABORATORY SOP LIST (CONTINUED)

Extractable Base/Neutral and Acid Organic Compounds in Liquid by EPA Method 625	S-MN-O-532
Determination of Parent and Alkylated PAH Compounds in Solid and Liquid Matrices by GC/MS SIM	S-MN-O-561
Analysis of Air samples by GC/MS - Method TO-13	S-MN-O-534
Qualitative ID of Biomarkers by SIM	S-MN-O-568
Sulfolane Extraction and Analysis in Liquid Matrices by GCMS	S-MN-O-569
High Volume Injection for 8270C SIM	S-MN-O-570
Sulfolane Extraction and Analysis in Solid Matrices by GC/MS: Capillary Column Technique	S-MN-O-572
Analysis of Volatile Organic Compounds by GC/MS Method 8260	S-MN-O-521
Analysis of Volatile Organic Compounds by GC/MS Method 624	S-MN-O-529
Analysis of Volatile Organic Compounds in Water Method 524.2	S-MN-O-546
Analysis of 1,4 Dioxane by Selective Ion Monitoring (SIM) GC/MS SW846 Method 8260B Modified	S-MN-O-558
Method For Sonicator Tuning	S-MN-O-414
Cleaning Glassware in the Organic Laboratory	S-MN-O-465
Determination of Acid Cleanup of PCB Extracts	S-MN-O-494
Sonication Extraction Technique (SW3550) for Base/Neutral and Acid Compounds	S-MN-O-495
Continuous Liquid-Liquid Extraction (SW3520) for Base/Neutral and Acid Compounds	S-MN-O-496
Spike Verification in the Organic Prep Lab	S-MN-O-497
Preparation of Anhydrous Sodium Sulfate for Extraction Purposes	S-MN-O-500
Nitrogen Evaporation Technique	S-MN-O-503
Sample Concentration Technique	S-MN-O-504
Separatory Funnel Extraction for Polyaromatic Hydrocarbons by 8270-SIM	S-MN-O-506
Solvent Exchange into Hexane	S-MN-O-509
Copper Cleanup Procedure for Polychlorinated Biphenyls	S-MN-O-527
Continuous Liq/Liq extraction for Method 8270C (Dual pH) by SW 3520C	S-MN-O-539
Soxhlet Extraction for PAH Analysis by GC/MS:SIM	S-MN-O-540
DrieRite Regeneration Procedure	S-MN-O-557
Percent Solids (Moisture)	S-MN-I-367
Separatory Funnel Extraction	S-MN-O-566
Data Archiving	S-MN-L-106
Reagent Water Quality	S-MN-L-110
Generation of EDD	S-MN-L-112
Preventative, routine, and non-routine maintenance	S-MN-L-114
Receipt and Storage of Laboratory Supplies	S-MN-L-117
Common Laboratory Calculations and Statistical Evalation of Data	S-MN-L-125
Data Reduction, Validation, and Reporting in the Env Lab	S-MN-L-132
Syringe Technique	S-MN-L-139
Procedure for Handling Aqueous Organic Extractable Samples Containing Sediment	S-MN-L-142
Purchasing Laboratory Supplies	S-MN-L-143
Calculating Acodes and Data Sensibility	S-MN-L-146
Quality Manual	Quality Manual
Precision and Accuracy Measurement, Evaluation, and Trend Assessment	S-MN-Q-205
Manual Integration	S-MN-Q-214
Control of Hazardous Energy Program - Lockout/Tagout	S-MN-Q-249
Method Validation and Modification Studies	S-MN-Q-252
Procedure for Handling of USDA regulated soils	S-MN-Q-253
Estimation of Measurement Uncertainty	S-MN-Q-255
Management of Change	S-MN-Q-257
PT Program	S-MN-Q-258
Evaluation and Qualification of Vendors	S-MN-Q-259
Use of A2LA Terms and Symbols	S-MN-Q-260
Conflict of Interest Plan	S-MN-Q-261
Corrective Action and Preventative Action	S-MN-Q-262
Monitoring Storage Units	S-MN-Q-263
Support Equipment	S-MN-Q-264
Method Detection Limit Studies	S-MN-Q-269
Review of Analytical Requests	S-MN-Q-270
Internal and External Audits	S-MN-Q-271
MCL Violation Reporting	S-MN-Q-272
Preparation of Standard Operating Procedures	S-MN-Q-273
Software Validation	S-MN-Q-274
Chemical Hygiene Plan/Safety Manual	S-MN-S-001
Waste Training Management Requirements	S-MN-S-002

ATTACHMENT V- LABORATORY SOP LIST (CONTINUED)

Waste Handling	S-MN-S-003
MN Contingency Plan	2011
MT Contingency plan	2011
Biochemical Oxygen Demand (BOD)	S-MN-I-348
Phenols	S-MN-I-354
Oil & Grease - 1664	S-MN-I-357
Hexavalent Chromiumin in Water, Wastewater, and Soil	S-MN-I-358
Alkalinity, Titrimetric	S-MN-I-365
Fluoride in Water and Wastewater	S-MN-I-470
Determination of Total and Ortho Phosphorus in Aqueous Samples by SmartChem	S-MN-I-473
Specific Conductivity	S-MN-I-474
Ortho Phosphorus	S-MN-I-477
Particulate Matter (PM10) (Method 5) in the Atmosphere	S-MN-I-484
Settleable Solids	S-MN-I-486
Standard Test Method for Screening Apparent Specific Gravity and Bulk Density Waste	S-MN-I-493
Determination of Total Recoverable Phenolics by Flow Injection Colorimetry	S-MN-I-494
Turbidity in Water	S-MN-I-501
Chlorine, Total Residual in Water	S-MN-I-502
Use and Maintenance of the Konelab	S-MN-I-507
Determination of Nitrate/Nitrite in surface/wastewaters by Flow Injection Analysis by SmartChem	S-MN-I-508
Determination of Chloride by Konelab	S-MN-I-509
Determination of Sulfate by Konelab	S-MN-I-510
Determination of Nitrite by Konelab(Spectrophotometric Method)	S-MN-I-514
Paint Filter Liquids Test	S-MN-I-516
Gravimetric Determination of Oil and Grease by SPE	S-MN-I-520
Dissolved Oxygen	S-MN-I-524
Measurement of pH in Water, Soil, and Waste	S-MN-I-526
Determination of TSP and PM 10	S-MN-I-527
Measurement of Solids in Water and Wastewater	S-MN-I-528
Total CN in Water - Macro Distillation	S-MN-I-529
Weak Acid Disociable Cyanide in Water - Macro Distillation	S-MN-I-530
Total Coliform Bacteria	S-MN-MB-001
Fecal Coliform by MF	S-MN-MB-002
Heterotrophic Plate Count	S-MN-MB-003
Total Coliform Bacteria by MF	S-MN-MB-005
Sample Container Sterility Verification	S-MN-MB-006
The Determination of Ammonia by SmartChem	S-MN-I-559
Determination of NO3/NO2 by SmartChem	S-MN-I-560
Cation - Anion Balance	S-MN-I-562
COD by Hach 2700	S-MN-I-563
Cyanide in Water by SmartChem	S-MN-I-564
Flashpoint	S-MN-I-569
Delta Airlines Anodizing Line	S-MN-I-582
Quality Control Recordkeeping For Bulk Asbestos Analysis	S-MN-I-533
Bulk Analysis Using Polarized Light Microscopy	S-MN-I-534
Microscope Adjustment - Phase Contrast	S-MN-I-535
Microscope Alignment	S-MN-I-536
Fiber Counts By NIOSH 7400 Using Excel Spreadsheet	S-MN-I-537
Asbestos Data Review	S-MN-I-545
Particle Size Analysis	S-MN-I-549
Coarse Fragment	S-MN-I-552
Volatile Petroleum Hydrocarbons (VPH)	S-MN-O-559
The Determination of Extractable Petroleum Hydrocarbons by Method MA-EPH	S-MT-O-001
Petroleum Hydrocarbons as Diesel in Water and Soil	S-MT-O-002
Purgeable Total Petroleum Hydrocarbons in Water and Soil	S-MT-O-003
Determination of Inorganic Anions by Ion Chromatography	S-MN-I-532
Volatile Organic Compounds by 8260B	S-MT-O-004
Determination of Ammonia Nitrogen by Automated Phenate	S-MN-I-542
Fluoride Distillation	S-MN-I-551
Water Soluble Sulfate and Chloride	S-MN-I-554
Nitrite by SM4500 NO2B	S-MN-I-556
Chlorophyll-a	S-MN-I-566
Acidity	S-MN-I-571

ATTACHMENT V- LABORATORY SOP LIST (CONTINUED)

Turbidity	S-MN-I-572
Available Nitrate and Ammonia	S-MN-I-573
Sulfate Sulfur	S-MN-I-574
The Determination of Percent Moisture in Soil and Solid Samples	S-MN-I-579
Measurement of pH in Water, Soil, and Waste	S-MN-I-581
Organic Matter	S-MT-I-001
Phosphorus, Ortho and Total	S-MT-I-002
Vegetative Fluoride	S-MT-I-003
Acid-Base Accounting - Sobek	S-MT-I-004
Sulfides	S-MT-I-005
pH Paste	S-MT-I-006
Specific Conductivity SW2510B	S-MT-I-007
Measurement of Solids in Water and Wastewater	S-MT-I-008
The Determination of Nitrate-Nitrite by Flow Analyzer	S-MT-I-009
TKN By Colorimetry	S-MT-I-010
Colormetric Hexavalent Chromium	S-MT-I-011
Total Sufur by LECO	S-MT-I-012
Water Extraction of Soil	S-MN-I-561
BP Course Fragment	S-MN-I-565
Water Soluble Sulfate and Chloride	S-MT-I-013
The Determination of Percent Moisture in Soil and Solid Samples	S-MT-I-014
Volatile Petroleum Hydrocarbons (VPH)	S-MT-O-005
Purgeable Total Petroleum Hydrocarbons in Water (8015 Mod / CA LUFT)	S-MT-O-006

ATTACHMENT VI- LABORATORY CERTIFICATION LIST (CURRENT AS OF ISSUE DATE)

Pace-Minnesota EPA ID: MN00064				
State	**Agency**	**Program**	**Cert #**	**Expiration**
A2LA	ISO 17025	Dioxin-DW, WW, HW	2926.01	10/31/2011
Alabama	Dept of Environmental Mgmt	Dioxin-DW	40770	11/30/2011
Alaska	Dept. of Environmental Conservation	Contaminated Sites (6010B, 6020, 8260B, PCBs, PAHs)	UST-078	8/10/2011
Alaska	Dept. of Environmental Conservation	Dioxin-DW	MN00064	8/29/2011
Arizona	Dept of Health Services	Dioxin-DW, WW, HW	AZ0014	12/14/2011
Arkansas	Dept of Environmental Quality	Dioxins	88-0680	6/19/2011
California	Dept of Health Services	Dioxin-DW, WW, HW	01155CA	8/31/2011
Colorado	Dept. of Public Health & Environment	Dioxin-DW	Pace Analytical	12/31/2011
Connecticut	Dept of Public Health	Dioxins	PH-0256	12/31/2011
Delaware	Health & Social Services	Dioxin-DW		
EPA Region 5	Water Division	Dioxin-DW	WD-15J	2/17/2012
EPA Region 8	Water Division	Dioxin-DW, DW		12/31/2011
Florida (NELAC)	Dept of Health Services	Diox-DW, WW, HW, Air Envir-DW, WW, HW, Air	E87605	6/30/2011
Georgia	Environmental Protection Division	Dioxin-WW, HW via NELAP	E87605	6/30/2011
Georgia	Dept of Natural Resources	Dioxin-DW	959	6/30/2010
Guam	Guam EPA	Dioxin-DW	Pace Analytical	10/21/2011
Idaho	Dept. of Health & Welfare	Dioxin-DW	Pace Analytical	12/31/2011
Hawaii	Dept of Health	Dioxin-DW	SLD	6/30/2011
Illinois	Illinois EPA	Dioxin-DW, HW, WW via NELAP	200011	12/11/2011
Indiana	Dept of Health	Dioxin-DW via EPA Region 5	C-MN-01	2/11/2011
Iowa	Dept.of Natural Resources	Dioxin-DW	368	6/1/2011
Kansas	Dept of Health and Environment	Dioxin-DW Envir-DW, WW, HW	E-10167	10/31/2011
Kentucky	Dept of Environmental Protection	Dioxin-DW	90062	12/31/2011
Louisiana	Department of Environmental Quality	Dioxin-WW, HW, Air	3086	6/30/2011
Louisiana	Department of Health and Hospitals	Dioxin-DW	LA090015	12/31/2011
Maine	Dept of Human Services	Dioxin-DW via EPA Region 5	2007029	5/27/2011
Maryland	Dept. of Heath and Mental Hygiene	Dioxin-DW	322	6/30/2011
Michigan	Dept. of Public Health	Dioxin, Metals-DW	9909	12/31/2011
Minnesota (NELAC)	Dept of Health	Envir-DW, WW, HW	027-053-137	12/31/2011
Minnesota	Department of Commerce	Petrofund	1240	12/31/2011
Mississippi	Dept. of Health and Environmental Control	Dioxin-DW	Pace	6/30/2011
Montana	Dept of Health	Dioxin-DW	92	1/1/2012
Nebraska	Dept. of Health & Human Services.	Dioxin-DW	Pace	6/30/2011
Nevada	Health Division	Dioxin-DW, WW	MN_00064_2000_72	7/31/2011
New Jersey	Dept of Environmental Protection	Dioxin-DW, WW, HW Envir-WW, HW, Air	MN002	6/30/2011
New Mexico	NM Environment Dept.	Dioxin-DW, Env-DW	Pace	6/30/2011
New York	Dept of Health	Dioxin-DW, WW, Air Envir-Air	11647	4/1/2011
North Carolina	Dept of Environment, Health and Natural Resources	Envir-WW, HW	530	12/31/2011

ATTACHMENT VI- LABORATORY CERTIFICATION LIST (CURRENT AS OF ISSUE DATE) CONTINUED

State	Agency	Program	Cert #	Expiration
North Carolina	State Public Health Laboratory	Dioxin-DW	27700	7/31/2011
North Dakota	Dept of Health and Consolidated Labs	Envir-DW, WW, HW	R-036	12/31/2011
Ohio	Ohio EPA	Dioxin-DW via EPA Region 5	4150	2/21/2011
Ohio Vap	VAP	Dioxin and Air	CL101	7/15/2012
Oklahoma	Dept of Environmental Quality	Dioxin-DW	D9921	8/31/2011
		Envir-HW	9507	8/31/2011
Oregon	ORELAP	Dioxin-DW, WW, HW, Air Enviro: Air	MN200001-005	8/14/2011
Oregon	ORELAP	NWTPH	MN300001-001	5/27/2011
Pennsylvania	Dept of Environmental Protection	Dioxin-DW, WW, HW Envir: DW, WW, HW	68-00563	3/31/2011
Puerto Rico	Hygiene Laboratories Certification Program	Dioxin, DW metals	MN00064	1/31/2012
Saipan (CNMI)	Div. Of Environmental Quality	Dioxin-DW	MP0003	9/18/2011
South Carolina	Dept. of Health and Environmental Control	Dioxin-DW, WW, HW	74003001	6/30/2011
Texas	Department of Health	Dioxin-DW, WW, HW	T104704192-08A-TX	2/28/2012
Tennessee	Dept of Health	Dioxin-DW Envir-DW	2818	4/11/2012
Utah	Department of Health	Dioxin-DW, WW, HW	ID# PAM Account# 6126071700	6/30/2011
Virginia	Dept of General Services	Dioxin-DW	251	6/30/2011
Washington	Dept of Ecology	Dioxin-DW, WW, HW Envir-DW, WW, HW	C754	2/18/2011
Wisconsin	Dept of Natural Resources	Dioxin-DW, WW, HW Envir-DW, WW, HW	999407970	8/30/2011
Wyoming	Via EPA Region 8	Dioxin DW		12/31/2011
West Virginia	Dept of Health and Human Resources	Dioxin-DW	9952C	12/31/2011

Pace-Montana EPA ID: MT00012				
Colorado-MT	Colorado Dept of Public Health and Environment	Asbestos Registration	17119	3/15/2011
EPA Region 8-MT Lab	Water Division	Dioxin-DW		6/30/2012
Idaho-MT Lab	Dept. of Health & Welfare	Dioxin-DW	MT00012	6/30/2011
Minnesota - MT Lab	Department of Health	Envir-DW, WW, HW	030-999-442	12/31/2011
Montana-MT Lab	Department of Health	DW	40	6/30/2012
NVLAP-MT Lab		Asbestos	101292-0	3/31/2011

The scope and application certificates are maintained in the filing cabinets in the QA Department.

ATTACHMENT VI- LABORATORY CERTIFICATION LIST (CURRENT AS OF ISSUE DATE) CONTINUED

MN00064 NELAC Accreditation*

Drinking Water Methods

EPA 524.2	SM 4500 Cl-E	SM 4500 NO2-B	SM 2320B
EPA 1613	SM4500 Cl-G	SM 4500 P-E	SM 2340B
	SM 4500 CN-E	EPA 120.1	SM 2540C
	SM 4500 CN-G	EPA 180.1	SM 9215B
	SM 4500 F-C	EPA 200.7	SM 9223B
	SM 4500 H+-B	EPA 200.8	ASTM D516-02
		EPA 245.1	EPA 353.2

Non-Potable Water

EPA 1613B	EPA 8270 SIM	SM 2320B	SM 3500 Cr-B
EPA 1668A	EPA 120.1	SM 2340B	SM 4500 Cl-E
EPA 624	EPA 160.4	SM 2540 B	SM 4500 Cl-G
EPA 625	EPA 180.1	SM 2540 C	SM 4500 CN-E
EPA 8015C	EPA 350.1	SM 2540 D	SM 4500 CN-G
EPA 8021B	EPA 410.4	SM 2540 F	SM 4500 H+-B
EPA 8082	EPA 420.1	SM 5220D	SM 4500 NO2-B
EPA 8260B	EPA 420.4	SM 5210B	SM 4500 NO3-H
EPA 8270C	EPA 1664A	EPA 6010	SM 4500 P-E
EPA 8280	EPA 200.7	EPA 6020	SM4500 O-G
EPA 8290A	EPA 200.8	EPA 7470A	SM9222B
WiDRO	EPA 245.1	EPA 7196A	SM9222D
WiGRO	EPA 353.2	ASTM D516-02	ASTM D516-02
NWTPH-Dx	WiGRO		
NWTPH-Gx	WiDRO		

Solid/Chemical Materials

EPA 8015C	EPA 8270 SIM	EPA 1311	EPA 9045C
EPA 8021B	EPA 1613B	EPA 1312	EPA 7196A
EPA 8082	EPA 1668A	EPA 6010B	EPA 9071
EPA 8260B	WiDRO	EPA 6020	EPA 9095B
EPA 8270C	WiGRO	EPA 7471A	
EPA 8280	NWTPH-Dx	WiGRO	
EPA 8290	NWTPH-Gx	WiDRO	
EPA 8290A			

Biological Tissues

EPA 8290	EPA 1613B	EPA 1668A
EPA 8290A		

Air and Emissions

EPA TO3	EPA TO9A	EPA TO14A	RSK-175
EPA TO4A	EPA TO13A	EPA TO15	Method 23
Method 3C			

*Pace-MN carries primary NELAC accreditation for these tests in one or more states. Actual coverage in a specific state or territory should be verified prior to performing analysis.

ATTACHMENT VI- LABORATORY CERTIFICATION LIST (CURRENT AS OF ISSUE DATE) CONTINUED

MT00012 NELAC Accreditation*

Drinking Water Methods

EPA 300.0	EPA 353.2	SM 4500 H+-B
SM 4500 P-E		

Non-Potable Water

EPA 300.0	EPA 353.2	SM 4500 NO2-B
EPA 350.1	SM2310B	SM 4500 P-E
EPA 351.2	SM 4500 H+-B	SM 4500 S2-D
Total Organic Nitrogen (calc.)		

*Pace-MT carries primary NELAC accreditation for these tests in one or more states. Actual coverage in a specific state or territory should be verified prior to performing analysis.

ATTACHMENT VII- PACE CHAIN-OF-CUSTODY (CURRENT AS OF ISSUE DATE)

CHAIN-OF-CUSTODY / Analytical Request Document

The Chain-of-Custody is a LEGAL DOCUMENT. All relevant fields must be completed accurately.

Pace Analytical™ www.pacelabs.com

Page: of

Section A Required Client Information: Company: Address: Email To: Phone: Fax: Requested Due Date/TAT:

Section B Required Project Information: Report To: Copy To: Purchase Order No.: Project Name: Project Number:

Section C Invoice Information: Attention: Company Name: Address: Pace Quote Reference: Pace Project Manager: Pace Profile #:

REGULATORY AGENCY

☐ NPDES ☐ GROUND WATER ☐ DRINKING WATER

☐ UST ☐ RCRA ☐ OTHER

Site Location STATE:

Requested Analysis Filtered (Y/N)

ITEM #	Section D Required Client Information — SAMPLE ID (A-Z, 0-9 / , -) Sample IDs MUST BE UNIQUE	Matrix Codes MATRIX / CODE: Drinking Water DW; Water WT; Waste Water WW; Product P; Soil/Solid SL; Oil OL; Wipe WP; Air AR; Tissue TS; Other OT	MATRIX CODE (see valid codes to left)	SAMPLE TYPE (G=GRAB C=COMP)	COLLECTED: COMPOSITE START DATE	COMPOSITE START TIME	COMPOSITE END/GRAB DATE	COMPOSITE END/GRAB TIME	SAMPLE TEMP AT COLLECTION	# OF CONTAINERS	Preservatives: Unpreserved	H_2SO_4	HNO_3	HCl	NaOH	$Na_2S_2O_3$	Methanol	Other	Y/N	Analysis Test	Residual Chlorine (Y/N)	Pace Project No./ Lab I.D.
1																					
2																					
3																					
4																					
5																					
6																					
7																					
8																					
9																					
10																					
11																					
12																					

ADDITIONAL COMMENTS	RELINQUISHED BY / AFFILIATION	DATE	TIME	ACCEPTED BY / AFFILIATION	DATE	TIME	SAMPLE CONDITIONS	Temp in °C	Received on Ice (Y/N)	Custody Sealed Cooler (Y/N)	Samples Intact (Y/N)

SAMPLER NAME AND SIGNATURE

PRINT Name of SAMPLER:

SIGNATURE of SAMPLER: DATE Signed (MM/DD/YY):

ATTACHMENT VIII- METHOD HOLD TIME*, CONTAINER AND PRESERVATION GUIDE (CURRENT AS OF ISSUE DATE)

* THE HOLDING TIME INDICATED IN THE CHART BELOW IS THE MAXIMUM ALLOWABLE TIME FROM COLLECTION TO EXTRACTION AND/OR ANALYSIS PER THE ANALYTICAL METHOD(S). FOR METHODS THAT REQUIRE PROCESSING PRIOR TO ANALYSIS, THE HOLDING TIME IS DESIGNATED AS 'PREPARATION HOLDING TIME/ANALYSIS HOLDING TIME'.

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
2, 3, 7, 8-TCDD	1613B	Soil	8oz Glass	None	1 yr
2, 3, 7, 8-TCDD	1613B	Water	1L Glass	≤6°C; $Na_2S_2O_3$ if Cl present	1 yr
2, 3, 7, 8-TCDD	8290	Water	1L Glass	≤6°C; $Na_2S_2O_3$ if Cl present	30/45 Days
Acidity	SM2310B	Water	Plastic/Glass	≤6°C	14 Days
Alkalinity	SM2320B/310.2	Water	Plastic/Glass	≤6°C	14 Days
Alpha Emitting Radium Isotopes	9315/903.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Anions by IC, including Br, Cl, F, NO_2, NO_3, SO_4	300.0/300.1/ SM4110B	Water	Plastic/Glass	≤6°C	Br, Cl, F, SO_4 (28 Days) NO_2, NO_3 (48 Hours)
Anions by IC, including Br, Cl, F, NO_2, NO_3, SO_4	300.0/9056	Soil	Plastic/Glass	≤6°C	Br, Cl, F, SO_4 (28 Days) NO_2, NO_3 (48 Hours)
Aromatic and Halogenated Volatiles	8021	Soil	5035 vial kit	See 5035 note*	14 days
Aromatic and Halogenated Volatiles	601/602/8021	Water	40mL vials	pH<2 HCl; ≤6°C; $Na_2S_2O_3$ if Cl present	14 Days
Acid Volatile Sulfide	Draft EPA 1629	Soil	8oz Glass	≤6°C	14 Days
Bacteria, Total Plate Count	SM9221D	Water	Plastic/WK	≤6°C; $Na_2S_2O_3$	24 Hours
Base/Neutrals and Acids	8270	Soil	8oz Glass	≤6°C	14/40 Days
Base/Neutrals and Acids	625/8270	Water	1L Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Base/Neutrals, Acids & Pesticides	525.1/525.2	Water	1L Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/30 Days
BOD/cBOD	SM5210B	Water	Plastic/Glass	≤6°C	48 hours
BTEX/Total Hydrocarbons	TO-3	Air	Summa Canister	None	14 Days
BTEX/Total Hydrocarbons	TO-3	Air	Tedlar Bag	None	48 Hours
Cation/Anion Balance	SM1030E	Water	Plastic/Glass	None	None

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Chloride	SM4500Cl/9250/ 9251/9252	Water	Plastic/Glass	None	28 Days
Chlorinated Herbicides	8151	Soil	8oz Glass Jar	≤6°C	7/40 Days
Chlorinated Herbicides	8151	Water	1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Chlorinated Herbicides	515.1	Water	1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	14/28 Days
Chorine, Residual	SM4500Cl	Water	Plastic/Glass	None	15 minutes
Chlorophyll-a	SM10200H	Water	1L Opaque Jar	If pH ≥ 7, frozen; if acidic process promptly after filtration	28 days if frozen
COD	SM5220C/ 410.3/410.4	Water	Plastic/Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Color	SM2120B,C,E	Water	Plastic/Glass	≤6°C	48 Hours
Condensable Particulate Emissions	EPA 202	Air	Solutions	None	6 Months
Cyanide, Reactive	SW846 chap.7	Water	Plastic/Glass	None	28 Days
Cyanide, Total and Amenable	SM4500CN/9010/ 9012/335.4	Water		pH>12 NaOH; ≤6°C; ascorbic acid if Cl present	14 Days, 24 Hours if Sulfide present
Diesel Range Organics- TPH DRO	8015	Soil	8oz Glass Jar	≤6°C	14/40 Days
Diesel Range Organics- TPH DRO	8015	Water	1L Glass	≤6°C	7/40 Days
Diesel Range Organics (WI)	WI MOD DRO	Soil	8oz Glass Jar	≤6°C	10/47 Days
Diesel Range Organics (WI)	WI MOD DRO	Water	1L Glass	≤6°C	14/40 Days
Dioxins & Furans	TO-9	Air	PUF	None	7/45 Days
EDB & DBCP	504.1/8011	Water	40mL vials	≤6°C; $Na_2S_2O_3$ if Cl present	14 Days
Explosives	8330/8332	Water	1L Glass	≤6°C	7/40 Days
Explosives	8330/8332	Soil	8oz Glass Jar	≤6°C	14/40 Days
Fecal Coliform	SM9222D	Water	100mL Plastic	≤6°C	6 Hours
Fecal Coliform	SM9222D	Soil	100mL Plastic	≤6°C	6 Hours
Ferrous Iron	SN3500Fe-D	Water	Glass	None	Immediate
Flashpoint/Ignitability	1010/1030	Water	Plastic/Glass	None	28 Days
Fluoride	SM4500Fl-C,D	Water	Plastic	None	28 Days
Gamma Emitting Radionuclides	901.1	Water	Plastic/Glass	pH<2 HNO_3	180 days
Gas Range Organics	8015	Water	40mL vials	pH<2 HCl	14 Days
Gasoline Range Organics	8015	Soil	5035 vial kit	See 5035 note*	14 days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Gross Alpha (NJ 48Hr Method)	NJAC 7:18-6	Water	Plastic/Glass	pH<2 HNO_3	48 Hrs
Gross Alpha and Gross Beta	9310/900.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Haloacetic Acids	552.1/552.2	Water	40mL Amber vials	NH_4Cl; ≤6°C	14/7 Days
Hardness, Total ($CaCO_3$)	SM2340B,C/130.1	Water	Plastic/Glass	pH<2 HNO_3	6 Months
Heterotrophic Plate Count (MPC)	EPA 9215B	Water	100mL Plastic	≤6°C	24 Hours
Hexavalent Chromium	7196/218.6/ SM3500Cr	Water	Plastic/Glass	≤6°C	24 Hours
Hydrogen Halide & Halogen Emissions	EPA 26	Air	Solutions	None	6 Months
Lead Emissions	EPA 12	Air	Filter/Solutions	None	6 Months
Low Level Mercury	1631	Water	Glass	BrCl	90 days (if preserved and oxidized)
Mercury	7471	Soil	8oz Glass Jar	≤6°C	28 days
Mercury	7470/245.1/245.2	Water	Plastic/Glass	pH<2 HNO_3	28 Days
Metals	7300/7303	Air	Filters	None	6 Months
Metals (and other ICP elements)	6010	Soil	8oz Glass Jar	None	6 months
Metals (and other ICP elements)	6010/6020/200.7/ 200.8	Water	Plastic/Glass	pH<2 HNO_3	6 Months
Methane, Ethane, Ethene	EPA Mod 8015	Water	40mL vials	HCl	14 Days
Methane, Ethane, Ethene	RSK-175	Water	40mL vials	HCl	14 Days
Methane, Ethane, Ethene	EPA 3C	Air	Summa Canister	None	14 Days
Methane, Ethane, Ethene	EPA 3C	Air	Tedlar Bag	None	48 Hours
Methanol, Ethanol	EPA 8015	Water	40mL vials	≤6°C	14 Days
Methanol, Ethanol	EPA 8015	Soil	2oz Glass	≤6°C	14 Days
Nitrogen, Ammonia	SM4500NH3/350.1	Water	Plastic/Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Nitrogen, Kjeldahl	SM4500-Norg; 351.1/351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Nitrogen, Nitrate	SM4500-NO3/ 352.1	Water	Plastic/Glass	≤6°C	48 Hours
Nitrogen, Nitrate & Nitrite	SM4500-NO3/ 353.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Nitrogen, Nitrite	SM4500-NO2/ 353.2	Water	Plastic/Glass	≤6°C	48 Hours
Nitrogen, Organic	SM4500-Norg/ 351.2	Water	Plastic/Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Non-Methane Organics	EPA 25C	Air	Summa Canister	None	14 Days
Non-Methane Organics	EPA 25C	Air	Tedlar Bag	None	48 Hours
Odor	SM2150B	Water	Glass	≤6°C	24 Hours
Oil and Grease/HEM	1664A/SM5520B/ 9070	Water	Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Organochlorine Pesticides & PCBs	TO-4	Air	PUF	None	7/40 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Organochlorine Pesticides & PCBs	8081/8082/608	Water	1L Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Organochlorine Pesticides & PCBs	8081/8082	Soil	8oz Glass Jar	≤6°C	14/40 Days
Organophosphorous Pesticides	8141	Soil	8oz Glass Jar	≤6°C	14/40 Days
Organophosphorous Pesticides	8141	Water	1L Amber Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Oxygen, Dissolved (Probe)	SM4500-O	Water	Glass	None	15 minutes
Paint Filter Liquid Test	9095	Water	Plastic/Glass	None	N/A
Particulates	PM-10	Air	Filters	None	6 Months
Permanent Gases	EPA 3C	Air	Summa Canister	None	14 Days
Permanent Gases	EPA 3C	Air	Tedlar Bag	None	48 Hours
pH	SM4500H+B/9040/ 9041/150.2	Water	Plastic/Glass	None	15 minutes
Phenol, Total	420.1/420.4/9065/ 9066	Water	Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Phosphorus, Orthophosphate	SM4500P/365.1/365.3	Water	Plastic	Filter; ≤6°C	Filter within 15 minutes, Analyze within 48 Hours
Phosphorus, Total	SM4500P/ 365.1/365.3/365.4	Water	Plastic/Glass	pH<2 H_2SO_4; ≤6°C	28 Days
Phosphorus, Total	EPA 365.4	Soil	Plastic/Glass	≤6°C	28 Days
Polynuclear Aromatic Hydrocarbons	TO-13	Air	PUF	None	7/40 Days
Polynuclear Aromatic Hydrocarbons	8270 SIM	Soil	8oz Glass Jar	≤6°C	14/40 Days
Polynuclear Aromatic Hydrocarbons	8270 SIM	Water	1L Glass	≤6°C; $Na_2S_2O_3$ if Cl present	7/40 Days
Radioactive Strontium	905.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-226 Radon Emanation Technique	903.1	Water	Plastic/Glass	pH<2 HNO_3	180 days
Radium-228	9320/904.0	Water	Plastic/Glass	pH<2 HNO_3	180 days
Silica, Dissolved	SM4500Si-D	Water	Plastic	≤6°C	28 Days
Solids, Settleable	SM2540F	Water	Glass	≤6°C	48 Hours
Solids, Total	SM2540B	Water	Plastic/Glass	≤6°C	7 Days
Solids, Total (FOC)	ASTM D2974	Soil	Plastic/Glass	≤6°C	7 Days
Solids, Total Dissolved	SM2540C	Water	Plastic/Glass	≤6°C	7 Days
Solids, Total Suspended	SM2540D	Water	Plastic/Glass	≤6°C	7 Days
Solids, Total Volatile	SM2540E	Water	Plastic/Glass	≤6°C	7 Days
Specific Conductance	SM2510B/9050/120.1	Water	Plastic/Glass	≤6°C	28 Days
Stationary Source Dioxins &	EPA 23	Air	XAD Trap	None	30/45 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Furans					
Stationary Source Mercury	EPA 101	Air	Filters	None	6 Months, 28 Days for Hg
Stationary Source Metals	EPA 29	Air	Filters	None	6 Months, 28 Days for Hg
Stationary Source PM10	EPA 201A	Air	Filters	None	6 Months
Stationary Source Particulates	EPA 5	Air	Filter/Solutions	None	6 Months
Sulfate	SM4500SO4/9036/ 9038/375.2/ASTMD516	Water	Plastic/Glass	≤6°C	28 Days
Sulfide, Reactive	SW-846 Chap.7	Water	Plastic/Glass	None	28 Days
Sulfide, Total	SM4500S/9030	Water	Plastic/Glass	pH>9 NaOH; ZnOAc; ≤6°C	7 Days
Sulfite	SM4500SO3	Water	Plastic/Glass	None	15 minutes
Surfactants	SM5540C	Water	Plastic/Glass	≤6°C	48 Hours
Total Organic Carbon (TOC)	SM5310B,C,D/ 9060	Water	Glass	pH<2 H_2SO_4 or HCl; ≤6°C	28 Days
Total Organic Halogen (TOX)	SM5320/9020/ 9021	Water	Glass; no headspace	≤6°C	14 Days
Tritium	906.0	Water	Glass	pH<2 HNO_3	180 days
Turbidity	SM2130B/180.1	Water	Plastic/Glass	≤6°C	48 Hours
Uranium Radiochemical Method	908.0/ASTM D5174-97	Water	Plastic/Glass	pH<2 HNO_3	180 days
Volatiles	TO-14	Air	Summa Canister	None	30 Days
Volatiles	TO-14	Air	Tedlar Bag	None	48 Hours
Volatiles	TO-15	Air	Summa Canister	None	30 Days
Volatiles	8260	Soil	5035 vial kit	See 5035 note*	14 days
Volatiles	8260	Water	40mL vials	pH<2 HCl; ≤6°C; $Na_2S_2O_3$ if Cl present	14 Days
Volatiles	8260	Conc. Waste	5035 vial kit or 40mL vials	≤6°C	14 Days
Volatiles	624	Water	40mL vials	pH<2 HCl; ≤6°C; $Na_2S_2O_3$ if Cl present	14 Days (7 unpreserved)
Volatiles	524.1/524.2	Water	40mL vials	pH<2 HCl; ≤6°C; $Na_2S_2O_3$ if Cl present	14 Days
Alaska DRO	AK102	Soil	8oz Glass	≤6°C	14/40 Days
Alaska DRO	AK102	Water	1L Glass	pH<2 HCl; ≤6°C	14/40 Days
Alaska RRO	AK103	Soil	8oz Glass	≤6°C	14/40 Days

Parameter	Method	Matrix	Container	Preservative	Max Hold Time
Alaska GRO	AK101	Soil	5035 vial kit	See 5035 note*	14 Days
Alaska GRO	AK101	Water	40mL vials	pH<2 HCl; ≤6°C	14 Days

5035 Note: 5035 vial kit typically contains 2 vials water, preserved by freezing **or**, 2 vials aqueous sodium bisulfate preserved at 4°C, **and** one vial methanol preserved at ≤6°C **and** one container of unpreserved sample stored at ≤6°C.

Instruction Manual

HI 99121
Soil pH Test Kit

HANNA instruments®

www.hannainst.com

Dear Customer,

Thank you for choosing a HANNA instruments® product.

Please read this instruction manual carefully before using the instrument. This manual will provide you with the necessary information for correct use of the instrument, as well as a more precise idea of its versatility.

If you need additional technical information, do not hesitate to e-mail us at **tech@hannainst.com**.

This instrument is in compliance with the CE directives.

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PRELIMINARY EXAMINATION

Remove the test kit from the packing material and examine it carefully to make sure that no damage has occurred during shipping. If there is any damage, immediately notify your dealer.

Each kit includes:

- **HI 99121** portable pH meter
- **HI 1292D** pH electrode
- pH 4.01 & pH 7.01 buffer solutions (20 mL each)
- **HI 700663** cleaning solution for inorganic soil deposits
- **HI 700664** cleaning solution for organic soil deposits
- **HI 7051M** soil preparation solution
- **HI 721319** ground auger
- 3 x 1.5V AA alkaline batteries
- instruction manual
- rugged carrying case

Note: Save all packing material until you are sure that the instrument functions correctly. All defective items must be returned in the original packing with the supplied accessories.

WARRANTY

All Hanna Instruments **meters are warranted for two years** against defects in workmanship and materials when used for their intended purpose and maintained according to instructions. **The probes are warranted for a period of six months**.

This warranty is limited to repair or replacement free of charge.

Damage due to accidents, misuse, tampering or lack of prescribed maintenance are not covered.

If service is required, contact the dealer from whom you purchased the instrument. If under warranty, report the model number, date of purchase, serial number and the nature of the problem.

First obtain a Returned Goods Authorization number from the Customer Service department, then return the instrument with the Authorization number included along with shipment costs prepaid.

If the repair is not covered by the warranty, you will be notified of the charges. When shipping any instrument, make sure it is properly packaged for complete protection.

SOIL pH

pH is the measure of the hydrogen ion concentration [H^+]. Soil can be acid, neutral or alkaline, according to its pH value.
Fig. 1 shows the relationship between the scale of pH and types of soil. Most plants prefer a pH range from 5.5 to 7.5; but some species prefer more acid or alkaline soils. Nevertheless, every plant requires a particular range of pH, for optimum growth.

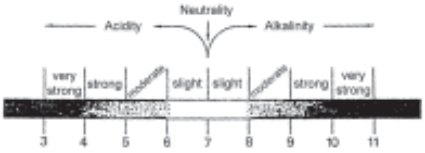


Fig. 1. Types of soil according to the pH value

pH strongly influences the availability of nutrients and the presence of microorganisms and plants in the soil.
For example, fungi prefer acidic conditions whereas most bacteria, especially those supplying nutrients to the plants, have a preference for moderately acidic or slightly alkaline soils. In fact, in strongly acidic conditions, nitrogen fixing and the mineralization of vegetable residual is reduced.
Plants absorb the nutrients dissolved in the soil water and the nutrient solubility depends largely on the pH value. Hence, the availability of elements is different at different pH levels (Fig.2).

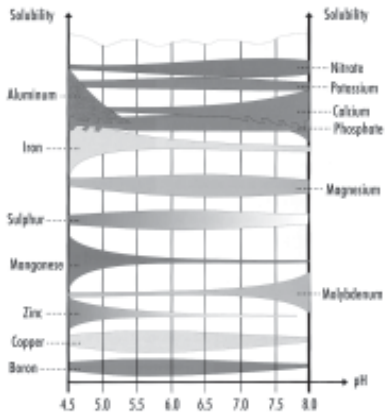


Fig. 2. Solubility of the elements according to varying pH

Each plant needs elements in different quantities and this is the reason why each plant requires a particular range of pH to optimize its growth.
For example, iron, copper and manganese are not soluble in an alkaline environment. This means that plants needing these elements should theoretically be in an acidic type of soil. Nitrogen, phosphorus, potassium and sulfur, on the other hand, are readily available in a pH range close to neutrality. Furthermore, abnormal pH values, increase the concentration of toxic elements for plants. For example, in acid conditions, there can be an excess of aluminum ions in such quantities that the plant can not tolerate.
Negative effects on chemical and physical structure are also present when pH values are too far from neutral conditions (break up of aggregates, a less permeable and more compact soil).

Management of the soil in relation to the pH value

Once the pH value is known, it is advisable to choose crops that are suitable for this range (e.g. in an acid soil, cultivate rice, potato, strawberry).
Add fertilizers that do not increase acidity (for example urea, calcium nitrate, ammonium nitrate and superphosphate) or lower alkalinity (e.g. ammonium sulfate).
It is recommended that a cost evaluation is made prior to commencement of the soil pH modification. Corrective substances can be added to modify the soil pH, however, the effects are generally slow and not persistent. For example, by adding lime, the effects in clay soil can last for as long as 10 years, but only 2-3 years in a sandy soil.
For an acid soil, we can use substances such as lime, dolomitic, limestone and marl, according to the nature of the soil (Tab.1).

Soil Ameliorants	Clay soil	Silty soil	Sandy soil
CaO	30-50	20-30	10-20
$Ca(OH)_2$	39-66	26-39	13-26
$CaMg(CO_3)_2$	49-82	33-49	16-33
$Ca\ CO_3$	54-90	36-54	18-36

Tab.1. Quantity (q/ha) of pure compound necessary to increase 1 unit of pH

High pH levels can depend on different elements, hence, there are different methods for its correction.

- Soils rich with limestone:

Add organic matter (this is due to the fact that non-organic ameliorants such as sulfur and sulfuric acid might not make economic sense due to the large quantities needed).

- Alkaline-saline soils:

Alkalinity is due to the presence of salts (in particular a high concentration of sodium can be harmful).

Irrigation washes away salts, hence, an appropriate use of irrigation can provide positive results (drop-irrigation being the most recommended).

If alkalinity is caused by sodium, it is recommended to add substances such as gypsum (calcium sulfate), sulfur or other sulfuric compounds (Tab.2). Also in this case, a cost evaluation is necessary.

Soil ameliorants (pure compounds)	Quantity (kg)
Calcium chloride: $CaCl_2 \cdot 2H_2O$	85
Sulfuric acid: H_2SO_4	57
Sulfur: S	19
Iron sulfate: $Fe_2(SO_4)_3 \cdot 7H_2O$	162
Aluminum sulfate: $Al_2(SO_4)_3$	129

Tab.2. Quantities provide the same result as 100 kg of gypsum

Procedure for direct ground measurement

1) Dig, discarding 5 cm of topsoil
2) Perforate the soil (with **HI 721319** soil drill) to a depth of about 20 cm or more
3) If the soil is dry, moisten it with a small amount of distilled water
4) Wash the electrode with tap water (not distilled)
5) Insert the electrode pushing it slightly into the soil to ensure proper contact
6) Observe the measurement
7) Wash the electrode with tap water (not distilled) and (using a finger) gently remove any soil remaining on the electrode (avoid using a rag or cloth)
8) Repeat the procedure in different locations in the field
9) Consider the average of the measured data

For best result, it is advisable to measure the pH of a soil solution, using a sample of soil and soil preparation solution **HI 7051**; it is better to use this procedure if you have to test a stony field in which you risk damaging the electrode.

Procedure for the measurement of soil solution (1:2,5)

A) Sampling

1) Extracting Soil Sample.
   Take 1 sample per 1000 m^2 (0.25 acre) of homogeneous area.
   Even for small areas, 2 samples are recommended (the more the samples, the better the end-results, because the result is more representative).
2) Avoid extracting samples from soil presenting obvious anomalies and consider them separately.
3) Sample quantity:
   Take the same quantity of soil for each sample. For example, use bags with similar dimensions (1 bag per sample).
4) Depth of extraction:
   General: dig and discard 5 cm (2") of topsoil.
   Herbaceous crops: from 20 to 40 cm of depth (8" to 16").
   Orchards: from 20 to 60 cm of depth (8" to 24").
5) Spread the soil samples on the pages of a newspaper and let the soil dry in a shady place or put it in an oven at 40°C.
6) Crumble the dried soil and mix all the samples together to obtain a homogeneous mixture, discarding stones and vegetable residues.
7) From this mixture, take the soil sample for analysis.

B) Soil solution preparation and measurement

1) Sift the soil at 2 mm.
2) Weigh 10 g of soil and put it in 25 ml of soil preparation solution **HI 7051** (use the apposite beaker) or 20 g of soil per 50 ml of soil preparation solution **HI 7051**.
3) Mix for 30 seconds.
4) Wait for about 5 minutes.
5) Mix again and measure the pH of the solution.

ORGANIC SUBSTRATE

pH measurements of organic substrates is important in greenhouses and nursery growing pots. pH should be checked at the outset to make sure that the pH of the substrate bought is that desired (pH can change if too much time elapses from the date of packaging to the moment of utilization).

A) Direct measurement in pot

If the substrate is dry, add a little distilled water. Insert the electrode into the soil and take measurement.

B) Measurement of the organic substrate solution (1:2)

Let the substrate dry and discard the coarse vegetable residues and pebbles.

Prepare a solution composed of 1 part of mould and 2 parts of **HI 7051** solution (for example: fill the beaker with the substrate up to 50 ml, press it gently, empty the content in another container and add 100 ml of **HI 7051** solution).

Mix for 30 seconds and then wait for 5 minutes. Mix again and measure the pH of the solution.

IRRIGATION WATER

The quality of irrigation water is a very important factor. If the pH value is very far from pH 7, it is possible that other anomalies are present.

Ranges for evaluation of water quality:

- 6 to 8.5 pH: good, it can be utilized without problems.
- 5 to 6 pH or 8.5 to 9 pH: sufficient, sensible crops could have problems.
- 4 to 5 pH or 9 to 10 pH: scarce, use it carefully, avoid wetting the vegetation.
- pH<4 or pH>10: very scarce, there are other anomalies that have to be identified via chemical analysis.

NUTRIENT SOLUTION

A rational fertilization is needed for optimum plants growth in greenhouses. The pH value of the nutrient solution (water + fertilizer) has to meet the plants need.

If a fertirrigation system with automatic pH control is used, ensure that it is functioning properly.

Check the pH of the irrigation solution as well as any recycled solution.

ORCHARD PLANTS

	Preferred pH Range		Preferred pH Range
Apple	5-6.5	Orange	5-7
Apricot	6-7	Peach	6-7.5
Cherry	6-7.5	Pear	6-7.5
Grapefruit	6-7.5	Plum	6-7.5
Grapevine	6-7	Pomegranate	5.5-6.5
Lemon	6-7	Walnut	6-8
Nectarine	6-7.5		

VEGETABLES AND HERBACEOUS CULTIVATIONS

	Preferred pH Range		Preferred pH Range
Artichoke	6.5-7.5	Pepper	6-7
Asparagus	6-8	Early Potato	4.5-6
Barley	6-7	Late Potato	4.5-6
Bean	6-7.5	Sweet Potato	5.5-6
Brussels Sprout	6-7.5	Pumpkin	5.5-7.5
Early carrot	5.5-7	Rice	5-6.5
Late carrot	5.5-7	Soybean	5.5-6.5
Cucumber	5.5-7.5	Spinach	6-7.5
Egg Plant	5.5-7	Strawberry	5-7.5
Lettuce	6-7	String	6-7.5
Maize	6-7.5	Sugar beet	6-7
Melon	5.5-6.5	Sunflower	6-7.5
Oat	6-7	Tomato	5.5-6.5
Onion	6-7	Watermelon	5.5-6.5
Pea	6-7.5	Wheat	6-7

LAWN

	Preferred pH Range
Lawn	6-7.5

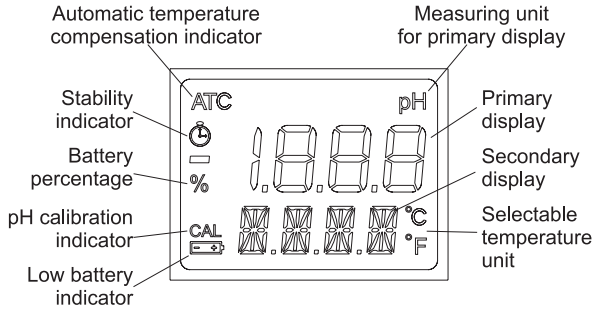
GARDEN PLANTS AND FLOWERS

	Preferred pH Range		Preferred pH Range
Acacia	6-8	Ligustrum	5-7.5
Acanthus	6-7	Magnolia	5-6
Amaranth	6-6.5	Narcissus	6-8,5
Bougainvillea	5.5-7.5	Oleander	6-7.5
Dahlia	6-7.5	Paulownia	6-8
Erica	4.5-6	Portulaca	5.5-7.5
Euphorbia	6-7	Primula	6-7.5
Fuchsia	5.5-7.5	Rhododendron	4.5-6
Gentian	5-7.5	Roses	5.5-7
Gladiolus	6-7	Sedum	6-7.5
Hellebore	6-7.5	Sunflower	5-7
Hyacinth	6.5-7.5	Tulip	6-7
Iris	5-6.5	Viola	5.5-6.5
Juniper	5-6.5		

HOUSE PLANTS

	Preferred pH Range		Preferred pH Range
Abutilon	5.5-6.5	Gardenia	5-6
African violet	6-7	Geranium	6-8
Anthurium	5-6	Hibiscus	6-8
Araucaria	5-6	Jasmine	5.5-7
Azalea	4.5-6	Kalanchoe	6-7.5
Begonia	5.5-7.5	Mimosa	5-7
Camellia	4.5-5.5	Orchid	4.5-5.5
Croton	5-6	Palms	6-7.5
Cyclamen	6-7	Peperomia	5-6
Dieffenbachia	5-6	Philodendron	5-6
Dracaena	5-6	Yucca	6-7.5
Freesia	6-7.5		

pH METER SPECIFICATIONS



Range (*)	-2.00 to 16.00 pH -5.0 to 105.0°C / 23.0 to 221.0°F
Resolution	0.01 pH / 0.1°C / 0.1°F
Accuracy (@20°C/68°F)	±0.02 pH ±0.5°C up to 60°C; ±1°C outside ±1°F up to 140°F; ±2°F outside
Temperature Compensation	Automatic
pH Calibration	Automatic, 1 or 2 point with 2 sets of memorized buffers
Probe (included)	**HI 1292D** pH/temperature probe
Battery Type / Life	3 x 1.5V AA (IEC LR6) / approx. 1500 hours
Auto-off	After 8 minutes of non-use
Environment	0 to 50°C (32 to 122°F); RH 100%
Dimensions	150 x 80 x 36 mm (5.9 x 3.2 x 1.4")
Weight	210 g (7.4 oz.)

(*) The temperature range is limited to 80°C (176°F) if using the **HI1292D** probe.

To clean the meter, use water only.

OPERATING THE pH METER

To connect the probe

With the meter turned off, connect the **HI 1292D** probe to the DIN socket on the top of the meter by aligning the pins and pushing in the plug. Tighten the nut to ensure a good connection. Remove the protective cap from the probe before taking any measurements.

To turn the meter ON and check the battery status

Press the ON/OFF/MODE button until the display lights up. At start-up, all the LCD segments are displayed for 1 second, then the percent indication of the remaining battery life is shown for another second (E.g. % 100 BATT). The meter then enters the normal measuring mode.

Note: If the display needs to be checked, keep the ON button pressed while turning the meter on. The meter will display all segments as long as the button is pressed.

To freeze the display

While in measurement mode, press the SET/HOLD button, HOLD appears on the secondary display and the reading will be frozen on the LCD (E.g. pH 5.73 HOLD). Press any button to return to normal mode.

To turn the meter OFF

While in normal measurement mode, press the ON/OFF/MODE button. OFF will appear on the secondary display. Release the button.

Note: The meter is provided with an acoustic signal feature, which can be disabled using the switch located in the battery compartment.

Note: When the meter detects the absence of a temperature probe at its input, the Automatic Temperature Compensation is turned off, and the meter uses a default value of 25°C (77°F) for the temperature measurement and compensation. In this condition, the secondary LCD shows 25.0°C (77.0°F) blinking. When a probe is connected, the meter automatically returns to the ATC mode, the ATC tag is turned on, and the temperature is shown on the secondary display.

pH MEASUREMENT & CALIBRATION

- Make sure the meter has been calibrated before use.
- If the probe is dry, soak it in **HI 70300** storage solution for one hour to reactivate it.
- Place the tip of the probe into the sample to be tested, stir briefly and wait until the stability symbol on the LCD is turned off.
- The LCD shows the pH value (automatically compensated for temperature) on the primary LCD, while the secondary LCD shows the temperature of the solution.
- If measurements are taken in different samples successively, rinse the probe tip thoroughly to avoid contaminations. After cleaning, rinse the probe tip with some of the sample to be measured.

pH calibration

For better accuracy, a **frequent electrode cleaning** (see also pag. 15) **and meter calibration** is recommended.
In addition, the instrument must be recalibrated whenever:

a) The pH electrode is replaced.
b) After testing aggressive chemicals.
c) Where high accuracy is required.
d) At least once a month.

- From normal mode, press & hold ON/OFF/MODE until OFF on the secondary display is replaced by CAL. Release the button.
- The LCD enters the calibration mode, displaying “pH 7.01 USE” (or “pH 6.86 USE” if the NIST buffer set was selected). After 1 second the meter activates the automatic buffer recognition feature. If a valid buffer is detected, then its value is shown on the primary display, and REC appears on the secondary LCD. If no valid buffer is detected, the meter keeps the USE indication active for 12 seconds, and then replaces it with WRNG, indicating that the sample being measured is not a valid buffer.
- For a *single-point calibration* with buffers pH 4.01, 9.18 or 10.01, the meter automatically accepts the calibration when the reading is stable; the meter will show on the primary display the accepted buffer, with the message “OK 1” on the secondary display, and an audible signal is produced. After 1 second the meter automatically returns to the normal measuring mode.
  If a single-point calibration with buffers pH 7.01 or 6.86 is desired, then after the calibration point has been accepted press the ON/OFF/MODE button in order to return to the normal measuring mode. After the button is pressed, the meter shows

"7.01" (or "6.86") - "OK 1", and an audible signal is produced. After 1 second, the meter automatically returns to the normal measuring mode.

Note: It is always recommended to carry out a two-point calibration for better accuracy.

- For a *two-point calibration*, place the probe in pH 7.01 (or pH 6.86) buffer. After the calibration point has been accepted, the "pH 4.01 USE" message appears. The message is held for 12 seconds, unless a valid buffer is recognized. If no valid buffer is recognized, then the WRNG message is shown. If a valid buffer (pH 4.01, pH 10.01 or pH 9.18) is detected, then the meter completes the calibration procedure. When the buffer is accepted, the LCD shows the accepted value with the "OK 2" message on the secondary display. The meter then returns to the normal measuring mode.

Note: When the calibration is completed, the CAL tag is turned on.

To quit calibration and to reset to the default values

- After entering the calibration mode and before the first point is accepted, it is possible to quit the procedure and return to the last calibration data by pressing ON/OFF/MODE. The secondary LCD displays ESC for 1 sec. and the meter returns to normal mode.
- To reset to the default values and clear a previous calibration, press the SET/HOLD button after entering the calibration mode and before the first point is accepted.
  The secondary LCD displays CLR for 1 sec, the meter resets to the default calibration and the "CAL" tag on the LCD disappears.

METER SETUP

Setup mode allows to select the temperature unit and the pH buffer set. To enter the Setup mode, press & hold ON/OFF/MODE until CAL on the secondary display is replaced by TEMP and the current temperature unit (E.g. TEMP °C). Then:

- *for °C/°F selection*, use the SET/HOLD button. After the temperature unit has been selected, press ON/OFF/MODE to enter the buffer set selection mode; press ON/OFF/MODE twice to return to the normal measuring mode.
- *to change the calibration buffer set*, after setting the temperature unit, the meter will show the current buffer set: "pH 7.01 BUFF" (for 4.01/7.01/10.01) or "pH 6.86 BUFF" (for 4.01/6.86/9.18). Change the set with the SET/HOLD button, then press ON/OFF/MODE to return to normal mode.

ELECTRODE CLEANING

A frequent cleaning of the pH electrode is strongly recommended to ensure correct calibration and reliable readings.

Hanna Instruments has developed a complete series of cleaning solutions dedicated to specific applications and kind of dirty that has to be removed from the electrode.

In soil measurements you can choose between two different solutions accordingly to the type of tested soil:

- **HI 700663** is indicated for inorganic soil deposits (as minerals, limestone, adsorbed clays)
- **HI 700664** is specific for organic soil deposits (humus)

If cleaning is performed frequently, soak the electrode in the specific solution for a few minutes.

If the electrode has not be cleaned for a while, for a complete removal of soil deposits, proceed as follows:

- wipe the electrode body (not bulb) with paper or soft tissue
- rub the reference with abrasive paper
- immerse into cleaning solution for at least 15 minutes.

BATTERY REPLACEMENT

The meter displays the remaining battery percentage when turned on. When the level is below 5%, the ▭ symbol on the bottom left of the LCD blinks to indicate a low battery condition. If the battery level is low enough to cause erroneous readings, the Battery Error Prevention System (BEPS) turns the meter off. Unscrew the 4 screws located on the back of the meter and carefully replace the 3 AA batteries located in the battery compartment, while paying attention to their polarity. Reattach the back making sure that the gasket is in place and tighten the 4 screws to ensure a watertight seal.

TECHNICAL SERVICE CONTACTS

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For e-mail contacts and complete list of Sales and Technical offices, please see ***www.hannainst.com***

MAN99121R3 09/05

Attachment II

Standard Operating Procedures

STANDARD OPERATING PROCEDURE NO. 1
IN-SITU MEASUREMENT OF SOIL PH

INSTRUMENT CALIBRATION

Calibrate pH meter daily before use following manufacturer's procedures. The instruction manual for the Hanna HI-99121 is attached to this SOP. The general calibration procedure is listed below.

1. A two or three point calibration will be performed and recorded each morning. Buffer solutions should bracket the expected range of pH.
2. Rinse pH electrode/temperature probe with **tap water** before use and between each pH buffer measurement. Distilled water may not be used to clean the probe.
3. Calibrate following manufacturer's procedure (attached).
4. After instrument calibration perform a calibration check by measuring pH 7 buffer solution. Values should be within 0.2 standard units of the pH buffer.
5. Remove electrode/temperature probe from buffer solution, rinse with **tap water**. Store pH/temperature probe in a pH storage solution. Do not allow the pH probe to dry out.
6. Buffer solutions should be discarded daily after use.
7. All calibration will be documented in field log book. All pH values, temperatures and the pH calibration slope will be recorded if available.

IN-SITU MEASURMENT OF SOIL pH

This procedure is for in-situ measurement of soil pH. A pH probe specifically designed for pH measurement of soils is recommended.

1. Perforate the soil to a depth of about 1-3 inches with an appropriate soil auger.
2. If the soil is dry, moisten it with a small amount of **distilled water**.
3. Insert the pH probe pushing it slightly into the soil to ensure proper contact.
4. Observe the pH values and record the pH and temperature when stable.
5. Clean sampling equipment (soil auger and pH probe) by rinsing with **tap water**. If visible contamination remains continue cleaning. Be careful to not scratch the pH electrode.

STANDARD OPERATING PROCEDURE NO. 2
EQUIPMENT DECONTAMINATION

The purpose of this section is to describe general decontamination procedures for field equipment in contact with contaminated soil sampling equipment must be decontaminated between sample collection points if it is not disposable. Field personnel must wear disposable latex or nitrile gloves while decontaminating equipment at the project site. Every precaution must be taken by personnel to prevent contaminating themselves with the wash water and rinse water used in the decontamination process.

The following should be done in order to complete thorough decontamination of durable sampling equipment such as shovels, trowels, soil augers:

1. Visually inspect sampling equipment for contamination; use stiff brush to remove visible material.
2. The general decontamination sequence for field equipment includes: wash with Liquinox or an equivalent degreasing detergent; rinse with tap water. Garden type sprayers may be utilized to contain wash and rinse solutions.
3. Decontaminated equipment will be protected from contamination if not used immediately.
4. All disposable items (e.g., paper towels, latex gloves) should be deposited into a garbage bag and disposed of in a proper manner.

Heavy equipment and tools used in the remediation process will be decontaminated prior to leaving the work area. Decontamination will first involve a brush down of equipment/vehicles in the work area to remove visible accumulations of materials from the body and tires. Limited quantities of water may be used to remove residual visible contamination following dry brushing; however, water use will be minimized.

STANDARD OPERATING PROCEDURE NO. 3
SAMPLE HANDLING AND DOCUMENTATION

1.0 PURPOSE AND SCOPE

The purpose of this SOP is to define the standard protocols for sample handling and documentation.

2.0 PROCEDURES FOR SAMPLE HANDLING, DOCUMENTATION, AND ANALYSIS

2.1 Sample Identification and Labeling

Samples collected during the remediation activities will be assigned unique sample identification numbers. These numbers are required for tracking the handling, analysis, and verification or validation status of all samples collected during monitoring. All sample labels will be filled out using waterproof ink. At a minimum, each label will contain the following information:

- Sample identification;
- Date and time of sample collection;
- Method of chemical preservation used (if any); and
- Sampler's initials.

2.2 Sample Containers, Preservatives, and Holding Times

2.2.1 Sample Containers

Proper sample preparation practices will be observed to minimize sample contamination and potential repeat analyses due to anomalous analytical results. Prior to sampling, commercially-cleaned sample containers will be obtained from the analytical laboratory. The bottles will be labeled as described in the previous section.

2.2.2 Sample Preservation

Samples are preserved in order to prevent or minimize chemical changes that could occur during transit and storage. Sample preservation should be performed immediately upon sample collection to ensure that laboratory results are not compromised by improper coordination of preservation requirements and holding times. Samples will be preserved immediately and stored on ice in coolers prior to shipping. Sample preservation requirements are presented in the project SAP and/or QAPP.

2.2.3 Sample Holding Times and Analyses

Sample holding times are established to minimize chemical changes in a sample prior to analysis and/or extraction. A holding time is defined as the maximum allowable time between sample collection and analysis and/or extraction, based on the nature of the analyte of interest and chemical stability factors. Holding times applicable for analytes are listed in project SAP and/or QAPP.

For most samples, preservation by cooling to 4°C is required immediately after collection while the samples are held for shipment and during shipment to the laboratory.

2.3 Sample Preparation and Shipping

After collection, samples will be labeled and prepared as described in the previous discussion, and placed on ice in an insulated cooler. The sample containers will be placed in re-closeable

plastic storage bags. Samples will then be placed right side up in a cooler with ice for delivery to the laboratory. The coolers will be taped shut and chain-of-custody seals will be attached to the outside of the cooler to ensure that the cooler cannot be opened without breaking the seal. Alternately, samples will be placed in a plastic bag and the bag will be sealed with a custody seal and placed into the cooler with double bagged ice for shipment.

2.4 Sample Documentation and Tracking

This section describes the information that should be provided in field notes and sample Chain-of-Custody documentation.

2.4.1 Field Notes

Documentation of observations and data acquired in the field provide information on sample acquisition, field conditions at the time of sampling, and a permanent record of field activities. Field observations and data collected during routine monitoring activities will be recorded in a field log. Field notebook and/or data sheet entries will, at a minimum, include the information listed below. Relevant SOPs should be consulted to supplement this list.

- Project name;
- Location of sample;
- Data and time of sample collection;
- Sample identification numbers;
- Description of sample (matrix sampled);
- Sample depth (if applicable);
- Sample methods, or reference to the appropriate SOP;
- Field observations (if applicable);
- Results of any field measurements; and
- Sampler’s name.

Changes or deletions in the field book or on the data sheets should be recorded with a single strike mark, and remain legible. Sufficient information should be recorded to allow the sampling event to be reconstructed without having to rely on the collector's memory.

All field logs will be signed on a daily basis by the person who has made the entries. Anyone making entries in another person's field log will sign and date those entries.

2.4.2 Sample Chain-Of-Custody

During field sampling activities, traceability of the sample must be maintained from the time the samples are collected until laboratory data are issued. Establishment of traceability of data is crucial for resolving future problems if analytical results are called into question and for minimizing the possibility of sample mix-up. Initial information concerning collection of the samples will be recorded in the field log book or on data sheets as described above. Information on the custody, transfer, handling and shipping of samples will be recorded on a Chain-of-Custody (COC) form provided by the laboratory.

The sampler is responsible for initiating and filling out the COC form. The COC will be signed by the sampler when he or she relinquishes the samples to anyone else. A COC form will be completed for each set of samples collected, and will contain the following information:

- Sampler's signature and affiliation

- Project number
- Date and time of collection
- Sample identification number
- Sample type
- Analyses requested
- Number of containers
- Signature of persons relinquishing custody, dates, and times
- Signature of persons accepting custody, dates, and times
- Any additional instructions to the laboratory.

The person responsible for shipping samples to the laboratory will sign the COC form, retain the third copy of the form, document the method of shipment, and send the original and the second copy of the form with the samples. Upon arrival at the laboratory, the person receiving the samples will sign the COC form and return the second copy to the Project Manager. Copies of all COC documentation will be compiled and maintained in the central files. The original COC forms will remain with the samples until the time of final disposition. The laboratory will send a copy of the original COC to the Operator. This will then be incorporated into the central files.

Appendix C

City of Casper Standard Specifications For Public Works

TETRA TECH

City of Casper Standard Specifications for Public Works

Wolcott Street Acid Sludge Remediation Project

Former Lobell Refinery Orphan Site 57.004 Casper, Wyoming

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June, 2012

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Preface

All construction activities completed by Tetra Tech and its Subcontractors shall be completed in accordance with City of Casper Standard Specifications for Public Works, dated January 2006. Compiled in this document are the specifications from the City of Casper Standard Specifications for Public Works relevant to the work anticipated to be performed by Tetra Tech and its Subcontractors on the Wolcott Street Acid Sludge Remediation project.

Construction activities on this project include:

- Road closure and traffic control during remediation activities
- The construction of roadway embankment after completion of the remediation activities.
- Preparation of subgrade for placement of base course.
- Placement of 6" of base course materials on roadway.
- Replacement of any curb, gutter or sidewalk removed or damaged during remediation activities.

All additional construction activities not covered by this Construction Specification Plan shall be done in accordance with City of Casper Standard Specifications for Public Works, dated January 2006.

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DIVISION 100

SECTION 101
GENERAL CONSTRUCTION REQUIREMENTS

101.01 Description.

To establish uniform requirements for construction of water distribution facilities, sanitary sewerage collection facilities, storm sewer collection systems, streets, and associated appurtenances which will enable the construction to be performed in accordance with Local, State, and Federal laws.

101.02 Definitions.

A**.** For the purposes of these specifications, the words and phrases set out in the following articles shall have the meanings as follows:

1. "City" means the governing body of the city of Casper, Wyoming.

2. "Contractor" means the individual, partnership, firm, or corporation contracting with the developer or the City which will be performing the work, or which will be performing the construction activities.

3. "Developer" means partnership, firm, or corporation developing property where construction will be performed.

4. "Engineer" means the consultant or project Engineer.

5. "Owner" means the individual, partnership, firm or corporation being the owner of record of property where construction will be performed.

6. "Underground facility" means any item of personal or public property buried or placed below ground for use in connection with the storage or conveyance of electronic, water, sewage, telephonic or telegraphic communications, cable television, electric energy, oil, gas, hazardous liquids, or other substances and including, but not limited to pipes, sewers, water, storm water, conduits, cables, valves, lines, wires, manholes, and attachments.

B. The following abbreviations shall have the designated meanings:

1. "APWA" means the American Public Works Association.

2. "ASTM" means the American Society for Testing and Materials.

3. "AWWA" means the American Water Works Association.

4. "AASHTO" means the American Association of State Highway & Transportation Officials.

C. Reference to a specific specification, i.e., AWWA C900, means the latest Edition of that specification.

101.03 Scheduling and Construction Progress.

A. Prior to the start of any work, the Contractor shall submit in writing to the Engineer for review, a progress schedule that shall be followed as closely as possible. Progress scheduling using critical path method is approved and encouraged. Once work has started on a street, it must be pursued continuously until all work on that street is finished.

1. The Contractor shall schedule a preconstruction conference prior to the start of work. Persons attending shall include representatives of the Contractor, subcontractors, owner, developer, Engineer, and affected utilities.

B. Each successive phase of work will follow the preceding phase as closely as possible so that the time any one street is under construction is kept to a minimum.

C. In the event that the work is not being accomplished expeditiously or in accordance with the time period set forth in the progress schedule, or if the work on an excavation has ceased or is abandoned without due cause, the Engineer may give written notice to the Contractor and/or the surety company for the project.

101.04 Notification of Landowners, Residents, and Businesses

A. At least one (1) week prior to beginning construction operations Contractor shall notify in writing, all those directly affected by the Work, including the Fire, Ambulance, Police Departments, and the Engineer's Office. The notification shall include the following as a minimum:

1. Name, address, telephone number, and contact person for Developer, Developer's Contractor, Owner, and Engineer.

2. A brief description of the proposed Work.

3. Name and telephone number of Contractor's person to contact in emergency.

4. A map showing the Work area, the traffic control plan, and the planned access to be provided to the affected properties. The map should also show the property or business owners' access during construction, and access in case of an emergency for fire, ambulance, police, or other emergency service agency vehicles.

5. A schedule for start up and completion of the Work. Schedules shall be updated as needed as the work progresses.

6. Contractor shall notify property owner and occupant 24 hours in advance of any disruption of service or access.

101.05 Available Maintenance Personnel

The Contractor shall have personnel available to maintain the Work as required, 24 hours per day every day. Accordingly, the Contractor shall furnish the City, the Owner, the Engineer, and

the Casper Police Dispatcher with the names, addresses, and telephone numbers of local employees or representatives who will be available to maintain the Contractor's work during non-working periods, evenings, nights, weekends, and holidays.

101.06 Utility Locates.

A. It is the responsibility of the Contractor to obtain locates for buried facilities within the project area prior to the start of work as necessary and as required by law. The Contractor is responsible for any damage to buried utilities or damage or injury to persons or property resulting from Contractor's work in the vicinity of the utilities. It is the responsibility of the Contractor to provide advance notice to all utility notification centers serving that area. The Contractor shall request the notification center to provide the nature, location, and elevation of the utility at each location and at whatever interval is necessary for the work. If the utility company cannot or will not provide the information, the Contractor shall obtain the information by whatever means are necessary. For each location that the utility is exposed, the Contractor shall locate the utility by tying it both horizontally and vertically by coordinates, to the datum established by the City.

B. At all utility crossings the Contractor shall locate the utility at a minimum of one point directly over the proposed line or appurtenance. When existing utilities that parallel the proposed line or appurtenance are exposed by excavation, the Contractor shall locate the utility by tying it both horizontally and vertically to the datum and include the information on the record drawings. At a minimum, the utility shall be tied horizontally and vertically at 300-foot (90 m) intervals.

C. If during the field location of the utilities, additional unforeseen utilities are discovered, the Contractor shall immediately notify the Engineer and proceed in accordance with approval of the Engineer. The utility must be located by the Contractor as specified above and include the information on the record drawings.

D. The Contractor must protect all existing utilities and improvements, public or private, located on the right-of-way, and other work areas, during the entire period of his work. Special care must be taken in backfilling and compacting under and around such improvements. Any breakage or damage to underground facilities caused by trenching, backfilling, resurfacing, or any other activity associated with the work shall be the responsibility of the Contractor.

E. Whenever utility mains or services are crossed, the utility owner shall be notified and the crossing shall be constructed in accordance with the utility owner's requirements.

F. Before the Contractor begins his grading operations, he shall confer with the owners of any underground or overhead utilities which may be in or in close proximity to the grading areas, and shall arrange for the necessary disconnection of these utilities in accordance with the regulations of the utility companies concerned. The Contractor shall take such measures as the Engineer may direct in protecting these utilities properly throughout the period his grading operations are in progress. The party or parties owning or operating overhead or underground utilities shall perform the actual work of moving, repairing, reconditioning, or revising the utilities, except as otherwise specified in this Section. Whenever and wherever such operations are undertaken by the owners of utilities, the Contractor shall cooperate to the extent that ample protection of their work will be provided so that the entire work as contemplated may be expedited to the best interests of all concerned, as judged by the Engineer.

G. Protect and safeguard existing service lines and utilities structures, the locations of which have been made known to the Contractor by the owners of the utilities or by others, prior to excavation or construction of fills or embankments, from damage during grading operations. Any damage to such lines or structures shall be repaired at the Contractor's expense. The above provisions are applicable to all service lines or utilities structures, all or any portion of which protrude above the original ground or street surfaces, or lie beneath such surfaces in any grading area or any other area upon which the Contractor has encroached.

101.07 Protection of Existing Buildings and Structures.

The Contractor shall guard against, and be responsible for, any movement, settlement, or collapse of adjacent buildings, sidewalks, structures, and underground or above ground utilities. The Contractor shall repair damage done to the owner's property or any other property, on or off the premises, by reason of his operations. The Contractor shall adequately brace walls during backfilling and compacting operations.

101.08 Construction Stakes – Alignment and Grades.

A. All work shall be constructed in accordance with lines and grades shown on the drawings and as designated by the Engineer. These lines and grades may be modified by the Engineer as provided in the General Conditions.

B. The Contractor shall provide experienced personnel, materials, and equipment necessary to complete all survey, layout, and measurement work. The Contractor shall keep the Engineer informed a reasonable time in advance, of the times and places he wishes to do work so that initial control points may be designated.

101.09 Restoration of Street Surface, Street Signs, Curbs, Driveways, Sidewalks, Irrigation and Landscaping.

A. Wherever existing improvements are removed, damaged or otherwise disturbed by Contractor’s activities, Contractor shall replace or repair the improvements to conditions equal to or better than the condition prior to the start of work. Any crushed rock, sod, or natural vegetation disturbed by the Contractor shall be replaced, rebuilt or restored to conditions equal to or better than the condition prior to the start of work.

101.10 Temporary Utilities, Public Access and Safety.

A. Contractor shall provide temporary water and sewer service to properties when permanent facilities will be out of service for eight (8) hours or longer, or when other circumstances make it necessary. Where service cannot be interrupted, such as sewer mains, Contractor shall provide plant and equipment to pump around the sections which are out of service.

B. Where the Engineer deems necessary, the Contractor shall provide access wherever possible to public and private property to prevent serious inconvenience to pedestrian and vehicular traffic. This shall not be construed to require the Contractor to provide such access at the times and locations where it will interfere with his construction progress. The Contractor shall furnish, place, and maintain sufficient flags, flares, barricades, signs, etc., along the location of his work in accordance with the Federal Highway Administration, "Manual on Uniform Traffic Control Devices." Flag persons shall be utilized if necessary to maintain safe traffic flow.

101.11 Erosion and Sediment Control

Erosion and sediment control shall be performed in accordance with Casper City Code Chapter 12.20 – Erosion and Sediment Control.

101.12 City Permits

All necessary permits shall be obtained prior to the beginning of any construction project. Those permits may include: City of Casper/WDEQ Permit to Construct, Excavation Permits, Traffic Control Permits, Bonds, and Erosion and Sediment Control Permit, as well as any other appropriate permits required for the project by the City.

101.13 Punchlist and Final Closeout

A. Initial City Punchlist

1. The Contractor, Owner, Engineer, and City personnel will conduct an initial walkthrough and develop a list of deficiencies that will be presented to the Contractor by the Engineer.

2. The Contractor, Owner, and Engineer will conduct a walkthrough identifying items to be corrected. A final punchlist will be developed by the Contractor and Engineer. The punchlist will contain dates for completion of the various identified items.
3. All items on the list will be completed to the satisfaction of the City prior to acceptance of the project and start of the one-year warranty period.

101.14 Submittals

The Contractor shall submit for approval by the Engineer a minimum of five (5) copies of data required by specific sections of this specification.

101.15 Workmanship and Cleanup.

A. All debris and rubbish caused by the operations of the Contractor shall be removed, and the areas occupied during his operations shall be left in a neat and presentable condition satisfactory to the Engineer. Construction cleanup and all backfill operations shall immediately follow installation of underground facilities. Cleanup shall be completed to allow local traffic on the street and access to driveways, parking lots, etc. During construction, all existing gutters, storm drains, runoff channels, etc. shall be kept clean of dirt, rubble, or debris which would impede the flow of storm sewer.

B. Excess, unsuitable, and waste materials from the project (including that from trench excavation, pavement removal, curbwalk removal, and grading operations), shall be suitably disposed of, offsite, by Contractor.

C. Excess material resulting from parkway and shoulder finishing and other final operations shall not be permitted to accumulate on the pavement surface and shall be removed concurrently with the finishing operations. Care shall be taken to prevent the entrance of this material into drainage structures or other waterways during the construction period. It shall be the responsibility of the Contractor to properly dispose of all excess material.

101.16 Design Mixes, Testing and Quality Assurance.

The testing requirements and cost responsibilities of design mixes, testing requirements, and quality assurance testing are listed in each specific section of these specifications. Unless specified by the contract documents, or addressed specifically within these Standard Specifications, the Owner will be responsible for moisture/density/compaction testing only. If the initial moisture/density/compaction test fails to meet the minimum standards as established by these specifications, the Contractor shall pay for any and all additional tests until a moisture/density/compaction test meeting the minimum standards is obtained.

DIVISION 200

SECTION 201
ROADWAY EARTHWORK

201.01 Description.

This section covers work for all excavations, embankments, grading, parkway finishing, and incidental excavation items for street earthwork.

201.02 Definitions.

A. Unclassified Excavation Above Subgrade. Unclassified excavation above subgrade is defined as any material excavated above the subgrade elevation within the street right-of-way which is placed in fill or disposed of as directed by the Engineer, and any material taken from borrow pits and deposited as embankments or fill within the streets above the proposed subgrade elevation.

B. Relative Compaction. Relative compaction is defined as the ratio, in percent, of the compacted filled dry density to the laboratory maximum density. The laboratory maximum dry density is defined in accordance with ASTM D4253 and D4254, Method C. Corrections for oversize material will be applied as determined by the Engineer.

C. Optimum Moisture Content (OMC). Optimum moisture content is defined by ASTM D698.

D. Unclassified Excavation Below Subgrade. Unclassified excavation below subgrade is defined as any material excavated below the subgrade elevation within the street paving width which is placed in fill or disposed of, as directed by the engineer, and any material taken from borrow pits and deposited as embankment or fill within the street paving width below the proposed subgrade elevation.

E. Imported Borrow Excavation. Imported borrow excavation shall consist of excavation made from borrow areas inside or outside the project limits, and outside the normal grading limits for completion of embankments.

201.03 Excavation to Grade.

A. Excavation shall be made to grade dimensions and cross-sections as shown on the plans or as directed by the engineer. The top of the finished subgrade shall be of such smoothness that when tested with a ten foot (10') (3m) straight edge it shall not show any deviation in excess of one-half inch (1/2") (12.5mm) from true grade as established by grade hubs or pins. Any deviations in excess of these amounts shall be corrected by loosening, adding, or removing materials, reshaping, and recompacting by wetting and rolling.

B. Excavation shall be done in two (2) stages. The first stage shall consist of the removal of material down to the top of the subbase. The second stage shall consist of removing the material from the top of the subbase to the top of the subgrade. When the first stage of excavation has been completed, the material at subbase grade shall be examined and inspected by the engineer. If the material at proper grade and depth conforms to or exceeds the requirements of material for subbase course, as specified in Division 400, Section 401, and as determined by the Engineer, further excavation will not be required and the subbase course will

be omitted. If suitable subbase material is not encountered, the excavation shall be completed until suitable material is encountered.

C. When naturally existing subbase material is used, it shall be rolled, watered, and treated as specified in Division 400, Section 401of these Specifications.

201.04 Subgrade Preparation.

A. Subgrade material shall be defined as that soil or other natural existing material in the street which supports the pavement. In the case of flexible type pavement, the subgrade shall be that surface supporting the prepared subbase, base, and surface course.

B. Excavation above subgrade shall be cut approximately one inch (1”) (25mm) above subgrade and the subgrade shall be scarified six inches (6”) (150mm) the moisture adjusted to within ±2% of optimum moisture content and compacted to at least 95% of maximum density as determined by ASTM D698. The compacted subgrade shall extend one foot (1') (.3m) beyond the outside edges of the pavement base course or from lip to lip of curbwalk gutter, if the latter is in place, and have a uniform density across the entire width of the street.

C. Excavation below subgrade shall be performed where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the engineer, will not provide a suitable foundation for the subbase or base course, the unsuitable material shall be removed to the depth specified by the engineer and replaced with acceptable material. Replacement material shall be moisture conditioned and compacted to a minimum of 95% maximum density, as determined by ASTM D698 and a moisture content of ± 2% of optimum.

201.05 Subgrade Protection.

During construction, subgrades and excavations shall be kept shaped and drained. Ditches and drains along the subgrade shall be maintained so as to drain effectively at all times. Where ruts occur in the subgrade, the subgrade shall be brought to grade, reshaped, and recompacted prior to placing of subbase or base course. The storage or stockpiling of materials on the subgrade will not be permitted. No subbase course shall be laid until the subgrade has been checked, proofrolled, and approved by the Engineer. Under no circumstances shall subbase or base material be placed on a muddy subgrade.

201.06 Imported Borrow Excavation.

A. Where fill is required for embankment, the fill shall be composed of clean earth, sand, or gravel, free from vegetable matter or other objectionable foreign material. The area to receive fill shall be stripped of all vegetation and other unsuitable material before fill placement is started. Slopes shall have surfaces broken up in such a manner that fill material will bond with existing surface as directed by the Engineer. The fill shall be placed in layers not to exceed six inches (6") (150mm) compacted thickness eight inches (8") (200mm) loose thickness. The material in each layer shall be moistened to within ± 2% of optimum moisture content as directed by the Engineer and shall be rolled until at least 95% of maximum density as measured by ASTM D698. When borrow is required, it shall be taken from a source approved by the Engineer. Fill shall be defined as imported borrow excavation.

B. All curbwalk shall be backfilled in the parkway (or shoulder) prior to laying any base course.

201.07 Parkway and Shoulder Finish.

Promptly after completion of curbwalk construction, the areas between the curbwalk and the property lines, shall be brought to a uniform, smooth grade, unless otherwise directed by the engineer. Hand raking may be required around trees and in areas where larger equipment cannot be used. Fill material placed in such areas shall be free from stones, sticks, or other materials which will be objectionable for seeding or sodding purposes. Backfill material shall be suitable for the growth of lawn grass. The backfill need not be compacted -- however, finished grade shall be left one inch (1") (25mm) high to allow for settlement. The Contractor shall maintain the parkway area until final acceptance.

201.08 Dust Control.

It shall be the responsibility of the Contractor to take such action as may be necessary to minimize pollution due to blowing dust. The normal method of dust control is spraying with water by means of a pressure water distributor. The Contractor shall provide on-site, at all times, a water truck to be used for dust abatement. If this method is used, care shall be taken to avoid development of mud holes and to avoid erosion. With the Engineer's approval, other methods of dust control may be utilized, such as hygroscopic materials. Such materials shall not be used if they may have a deleterious effect on future work to be accomplished on the surface to which they are applied, if they may harm vegetation with which they come in contact, if they may contribute to corrosion of metals, or if they are dangerous or irritating to humans or to animals.

201.09 Subgrade Proofrolling.

A. Before the placing of any type of hard surfacing on the finished subgrade, such subgrade shall be proofrolled with at least one pass of coverage for its full width and length with a self-propelled pneumatic roller. Ground contact pressure of all tires shall be 85-90 psi (585-621 kPa). At the discretion of the Engineer, the specified ground pressure may be lowered. When the proofrolling shows an area to be unstable, such area shall be brought to satisfactory stability by additional compaction, reworking, or removal of unsuitable material and replacement with acceptable material.

B. Schedules for Proofrolling.

1. All utilities, including laterals or service pipes located under the street or the curb, gutter, and sidewalk, must be in place before the proofrolling operation is performed.
2. Proofrolling shall not take place more than 24 hours prior to the placing of the concrete for the curb, gutter, and sidewalk section, or the hot mix asphalt street section.

3. The Owner, City representatives, and Engineer must be notified, and approval of the base given, prior to the installation of any portion of the street section including curb, gutter, and sidewalk.

SECTION 206

TEMPORARY TRAFFIC CONTROLS

206.01 Description

To establish uniform requirements for detours, signs and barricades, and traffic control plans associated with construction activities performed on or affecting City of Casper streets. All traffic control work shall comply with the "Standard Specifications for Road and Bridge Construction," Wyoming Highway Department, latest edition. The work in this article shall consist of furnishing, erecting, maintaining, relocating, and removing temporary traffic control devices at the locations specified on the drawings and as directed by the Engineer. All traffic control devices shall conform to the provision for construction signing as set forth in the Manual on Uniform Traffic Control Devices for Streets and Highways (MUTCD) latest edition.

206.02 Traffic Control Products

A. Sign Panels

1. Sign panels will be constructed of ¾" plywood conforming to plywood sign panels and barricades of the standard specification for road and bridge construction; or 6061-T6 or 5052-H38 aluminum alloy sheeting conforming to ASTM B209.

2. Wood sign panels will be backed with metal backing angles; except that backing is not required for those sign panels 48" x 60" or smaller.

3. Aluminum sign panels will be 0.125" thick and backed with metal backing angles; except that those sign panels 48" x 60" or smaller may be:

   i. 0.080" thick and backed with metal backing angles or 2 x 4 lumber; or,

   ii. Unbacked, 0.125" thick.

4. Special signs which are unique to the project, i.e., signs not shown on the plans or included in part VI of the MUTCD, and signs shown on the plans which contain a message that is unique to the project, will be furnished by the contractor, as specified on the plans, and erected by the Contractor. Posts and hardware for fixed special sign installations, and all equipment for portable special sign installations will be furnished by the contractor. Post lengths will be specified by the Engineer. Upon removal, the special sign panels, posts, hardware, and portable installation equipment will remain the property of the Contractor.

   i. Special signs will be erected on fixed mountings unless portable mountings are authorized by the Engineer.

B. Barrels will be plastic conforming to the MUTCD, with 6" wide reflective stripes.

C. Temporary markings

1. Temporary reflective pavement markings will be paint, preformed tape, or raised pavement markers, and will be suitable for use on either Portland cement concrete or asphalt pavements. Minimum acceptable standards are as follows:

    i. Paint used for temporary markings will be commercially manufactured highway striping paint. The paint will be applied without dilution.

    ii. All painted stripes will be 4" wide, and will be reflectorized by dropping or spraying glass beads onto the wet paint.

    iii. The reflective beads will conform to AASHTO Specification M247, type 1.

2. Temporary reflective pavement striping tape will be 4" wide, pressure sensitive tape manufactured for use as pavement striping.

    i. Striping tape applied to finished pavement surfaces which will be returned to normal traffic use will be a removable type.

    ii. Striping tape applied to temporary pavement surfaces which will be obliterated may be a non-removable type.

    ii. Striping tape applied to the surface of intermediate lifts of asphalt pavement may be non-removable type, and may be let in place. If a removable type is used, it will be removed before placing the next lift.

3. Temporary retro-reflective raised pavement markers manufactured by Astro Optics of Schaumburg, Illinois, Model No. TPM, or Stimsonite Products of Niles, Illinois, Model No. 66, or an approved equal will be acceptable.

4. Temporary retro-reflective motorist guidance markers manufactured by Davidson Plastic Company of Kent, Washington, Model NO. TRPM, or TOM, or an approved equal will be acceptable.

206.03 Traffic Control Plans

A. A complete traffic control plan shall be submitted to the Engineer and the Casper City Engineering office at least one week prior to the start of construction.

1. Traffic will be permitted to use the street at all times, unless a detour is specifically permitted on the drawings or by the Engineer. Access to all abutting residences and properties shall be maintained to the maximum extent possible.

2. The Contractor shall construct and maintain temporary crossings, complete with flagmen, whenever necessary to expedite the work or to maintain traffic. The Contractor shall furnish not less than two flagmen at each location where loading or depositing of material requires the turning of the trucks on any highway or street and where the operation of construction equipment endangers traffic. Temporary crossings shall be of ample size to safely carry the load which comes upon them.

i. The Contractor shall maintain the streets in a passable condition. The work shall be conducted so as to create a minimum of inconvenience to traffic.

ii. Excavations which traverse a street shall be limited to one-half the width of the street at any one time, unless an emergency situation exists which requires that the entire width of the street be excavated. City Engineer's office approval is required prior to excavation traversing an entire street.

3. The Contractor shall furnish sufficient signs and barricades to facilitate the directing of traffic. Unless directed otherwise by the Engineer, all signs and barricades shall conform to:

   i. Within City of Casper: "Manual on Uniform Traffic Control Devices (MUTCD), " latest edition.

   ii. On State highway right-of-way: "Traffic Control for Roadway Work Operations," current editions.

4. The Contractor shall have a sufficient number of barricades and signs on hand prior to the start of the construction

   i. Each detour sign shall be reflectorized and shall be illuminated with two battery-powered blinkers with six-inch (6") amber lenses.

   ii. All barricades shall have blinker lights on each end.

   iii. It shall be the Contractor's responsibility to make necessary checks and inspections of all lights and barricades every day, including Sundays and holidays.

5. Temporary suspension of work does not relieve the Contractor of the responsibility outlined in the above requirements.

206.04 Permits

A. The Contractor shall obtain all necessary permits from the City Engineer's office for any closure of any street or portion thereof, as provided in the Casper Municipal Code. Along with the permit application, the Contractor shall provide a sketch showing traffic routing and traffic control devices to be used. The construction traffic control sketch shall be approved by the City Engineer's office before the permit is issued.

206.05 Street Closure

A. The City Engineer may permit the closing of streets to all traffic for a period of time prescribed by the office if, in the City Engineer's Opinion, it is necessary.

DIVISION 300

SECTION 301
PORTLAND CEMENT CONCRETE

301.01 Description.

This Article covers work necessary to furnish and place Portland cement. All terms and words used within this Article shall as be defined by ASTM C125.

301.02 Materials.

A. Cement.

1. Cement, Regular. Portland Cement shall conform to all requirements of the "Standard Specifications for Portland Cement," ASTM. Specification C150 for Type II modified, low C3A (less than 5%).

B. Fine Aggregate.

1. Fine aggregate for concrete shall consist of sand and shall conform to the following ASTM requirements, ASTM C33, ASTM C136, and ASTM D75.

    i. General Composition. Concrete sand shall be composed of clean (washed), hard, durable, uncoated grains, free from injurious amounts of clay, dust, soft flaky particles, loam, shale, alkali, organic matter, or other deleterious matter. Fine aggregate shall not contain appreciable materials which have unsatisfactory expansive properties when combined with Portland Cement and water. When required by the Engineer, expansion tests shall be made. Expansion shall not exceed 0.2 percent at age of one year as determined by ASTM Designation C-342.

    ii. Sieve Analysis. Fine aggregate shall be graded within the following limits:

	% Passing by Weight	
Sieve	Min.	Max.
3/8" (9.5mm)	100	---
No. 4 (4.75mm)	95	100
No. 8 (2.36mm)	80	100
No. 16 (1.18mm)	50	85
No. 30 (600um)	25	60
No. 50 (330um)	10	30
No. 100 (150um)	2	10
No. 200 (75um)	0	4

Material shall be well graded and within the ranges stated above. For the purpose of determining the degree of uniformity, a fineness modulus determination shall be made upon representative samples submitted by the Contractor from such sources as he proposes to use. Fine aggregate from any one source having a variation in fineness modulus greater than 0.20 either way from a fineness modulus of the representative sample submitted by the Contractor, may be rejected. The fineness modulus is defined in ASTM Definition C-125.

iii. Deleterious Substances. The fine aggregate shall not contain more than the following maximum amounts of deleterious substances:

	Max. % of Weight
Clay lumps	1.0
Coal, lignite, or shale	1.0

The sum of the above materials and other deleterious substances such as shale, alkali, mica, coated, grains, or soft and flaky particles shall not exceed 4% by weight.

iv. Organic Impurities. Fine aggregate subjected to the colorimetric test as per ASTM C40 for organic impurities and producing a color darker than the standard shall be rejected unless it passes the mortar strength test as specified in Section 301.03(B) Organic Impurities ASTM C40.

v. Soundness. Fine aggregate shall not have a loss greater than 15 percent weighted average loss at 5 cycles when tested in magnesium sulfate. Tests shall be made in accordance with ASTM C88.

C. Coarse Aggregate. Coarse aggregate for concrete shall consist of crushed stone or gravel and shall conform to the following requirements:

1. General Composition.

i. Broken stone shall consist of clean (washed), hard, tough, durable fragments of rock (excluding schist, shale, or slate) of uniform quality throughout, shall be free from an excess of soft, thin, or elongated pieces, disintegrated stone, dirt, organic, or other injurious matter occurring either free or as a coating on the stone.

ii. Gravel shall consist of clean, hard, durable uncoated pebbles and shall be free from soft, thin, or laminated pieces, disintegrated stone, dirt, organic, or other injurious matter occurring either free or as a coating on the gravel.

iii. Coarse Aggregate shall not be obtained from sources of supply that contain appreciable percentages of material which is considered to have unsatisfactory expansive properties when it is combined with Portland Cement and water. Expansion shall be considered excessive when it exceeds 0.2 percent at age of one year. ASTM Designation C-342.

iv. Percent Crushed Stone. Not less than fifty percent (50%) of the coarse aggregate by weight shall have at least one (1) fractured face.

2. Sieve Analysis. The coarse aggregate shall be graded within one of the following limits. Aggregates for concrete shall be combined in proportions that will provide a mixture within the grading limits shown below, unless otherwise approved in writing by Owner.

% Passing by Weight

Nominal Size of Material:	1-1/2"(37.5mm)Max.		3/4"(20mm) Max.	
	Min.	Max.	Min.	Max.
Passing 1 1/2" (37.5mm)	---	100	---	---
Passing 1" (25mm)	95	100	---	100
Passing 3/4" (20mm)	---	---	90	100
Passing 1/2" (12.5mm)	25	65	---	---
Passing 3/8" (9.5mm)	---	---	20	55
Passing No. 4 (4.75mm)	0	10	0	10
Passing No. 8 (2.36mm)	0	5	0	5

3. Deleterious Substances. The coarse aggregate shall not contain more than the following maximum amounts of deleterious substances:

	Max. % of Weight
Clay lumps	0.5
Material passing No. 200 sieve	2.0
Shale or coal	1.00
Other deleterious substances such as friable, thin, elongated, or laminated pieces	3.0

The sum of the above and other deleterious material shall not exceed 5% by weight.

4. Soundness. When subjected to 5 cycles of the soundness test, as set forth in ASTM C88, the loss in weight of coarse aggregate weighted in accordance with the grading of a sample complying with the grading requirements specified, shall not exceed 18 percent when magnesium sulfate is used, 12 percent for sodium sulfate.

5. Abrasion. The coarse aggregate shall not have an abrasive loss greater than 40% as determined by ASTM C131.

D. Water for Concrete. The water shall be clean and free from objectionable amounts of oil, acid, alkali, organic matter, or other deleterious materials and shall not be used until the source of supply has been approved. If at any time the water from an approved source becomes of unsatisfactory quality or insufficient quantity, the Contractor will be required to provide satisfactory water from another source. Water of questionable quality shall be subject to the acceptance criteria of Table I, as specified in ASHTO T26.

E. Air-Entraining Admixture. The Contractor shall use a regular Portland Cement with the addition of an air-entraining admixture meeting requirements of ASTM C260. Air-entraining admixtures to be used in air-entrained concrete shall be Darex AEA, Neutralized Vinsol Resin, and Protex, or any other air-entraining agent meeting the approval of the Engineer. Air-entraining admixtures shall contain no chlorides. The air-entraining characteristics of the admixture, in suitable proportions in combination with Portland Cement, fine aggregate and water, within the limits of the proportion specified, shall be such that the resulting concrete will have a satisfactory workability, and the total air content shall be as herein specified for the concrete as determined by ASTM Test C-138 or by the air meter.

F. Chemical Admixtures. Chemical admixtures shall conform to ASTM C4 94, except TYPE C accelerating admixtures shall contain no chlorides, shall be non-toxic after thirty (30) days, and shall be compatible with air-entraining admixtures. The amount of admixture added to the concrete shall be in accordance with the manufacturer's recommendations.

G. Pozzolan Admixture. Pozzolan admixture shall conform to the requirements of ASTM C311 and ASTM C618-85 (including Table IA) for either Class C or Class F. The amount of fly ash shall not exceed 15 percent of the total weight of flash ash plus cement.

301.03 Sampling and Testing Materials.

A. Cement. Cement may be accepted on the basis of mill tests and the manufacturer's certification of compliance with the specifications, provided the cement is the product of a mill with a record for production of high quality cement. Certificates of compliance shall be furnished the Engineer by the Contractor, for each lot of cement furnished prior to use of cement in the work. This requirement is applicable to cement for job- mixed, ready-mixed, or transit-mixed concrete. Cement proposed for use where no certificate of compliance is furnished, or where, in the opinion of the Engineer, the cement furnished under certificate of compliance may have become damaged in transit or deteriorated because of age or improper storage, will be sampled at the mixing site and tested for conformance to the specifications.

1. Cement will be approved for use if it satisfactorily passes the fineness, soundness, and time of set test requirements specified, provided the general run of materials has been satisfactorily meeting the 28-day strength requirements. Any approved cement failing to pass the 28-day strength requirements, if unused, shall be rejected. If, in the judgement of the Engineer, it is considered necessary, other lots of shipments from the same mill may be held for the results of tests before being used.

2. If cement is supplied from a new source or from a source of unknown quality, it may be held for the results of strength test before being approved.

B. Fine and Coarse Aggregate. At least two (2) weeks in advance of the beginning of concrete work the Contractor shall submit to an approved materials testing laboratory approximately five hundred pound (500#) (225kg) samples of each concrete aggregate proposed for use. All tests which are necessary to determine the compliance of the concrete materials with these specifications shall be performed on these samples. These samples shall also be used by the laboratory as the basis for a concrete mix design. The results of all tests and the concrete mix design shall be submitted to and approved by the City Engineer prior to the start of any concrete work. Standards shall conform to the latest applicable codes. The sampling and testing shall conform to the following standard procedures:

FINE AGGREGATE

Sampling Aggregates	ASTM D75
Sieve Analysis	ASTM C117
Organic Impurities	ASTM C40
Fineness Modulus	ASTM C136
Soundness	ASTM C88
Clay Lumps	ASTM C142

COARSE AGGREGATE

Sampling Aggregates	ASTM D75
Sieve Analysis	ASTM C136
Percent Passing No. 200 Sieves	ASTM C117
Clay Lumps	ASTM C142
Soundness	ASTM C88

301.04 Storage of Materials.

A. Cement. The Contractor shall provide adequate protection for the cement against dampness. No cement shall be used that has become caked or lumpy. Accepted cement which has been held in storage more than 90 days after shipment from the mill shall be retested, and if failing to meet the requirements specified herein shall be rejected.

1. Accepted cement which has been stored in approved sealed bins at the mill for not more than six (6) months may be used without further testing unless a retest is specifically requested by the Engineer.

B. Aggregate. Aggregates shall be handled and stored in separate piles at the site in such manner as to avoid a separation of the coarse and fine particles and contamination by foreign materials. Sites for stockpiles shall be prepared and maintained in such a manner as to prevent the mixing of deleterious materials with the aggregate. The Contractor shall deposit material in stockpiles at the batching plant site until the moisture content becomes uniform. Stockpiles shall be built in layers not to exceed three feet (3') (1m) in height, and each layer shall be completed before beginning the next one.

1. Coning or building up stockpiles by depositing the materials in one place will not be permitted. The storing of aggregates in stockpiles, or otherwise, upon the subgrade or shoulders will not be permitted.

301.05 Concrete Mixture Requirements.

A. The concrete shall meet the following requirements:

TABLE OF CONCRETE REQUIREMENTS

Property		Min.	Max.
Cement factor	sks. per cu. yd. (sks/m3)	6 (7.9)	---
Water-cement ratio	gal. per sk. (l/sk)	4.5 (17)	5.5 (20)
Entrained air	percent	4.5	7.5
Slump	inches (mm)	2 (50)	4 (100)

Volume Ratio of Fine to Total Aggregates

	Min. Ratio	Max Ratio
1” (25mm) Aggregate	0.40	0.55
3/4" (20mm) Aggregate	0.35	0.50
1/2" (12.5mm) Aggregate	0.30	0.46

Minimum Compressive Strength

28 day	psi(kPa)	4000 (27,600)

1. If it is found impossible to produce concrete having the required air content with the materials and mixing procedures that are being used, the Contractor shall make such changes in the materials or mixing procedures, or both, as may be necessary to insure full compliance with the requirements of air content in the concrete.

2. The total weight of aggregates per sack of cement and the relative proportions of coarse and fine aggregate shall be determined by yield tests made during the progress of the work. The Engineer may, at his discretion, adjust the laboratory mix design to obtain the proper yield, and consistency of concrete.

3. The Contractor shall receive written permission from the Engineer prior to adding Pozzolan admixture to Portland Cement Concrete.

4. Any combination of aggregates which requires the use of more than six and one-half gallons (6.5g) (25*l*) of water per sack of cement to produce a workable mixture, with the brand of cement used will be considered as being unsatisfactory, and all such combinations of aggregate will be rejected.

5. Coarse aggregate having moisture absorption of more than 1.0 percent (1%) (as computed from oven dry to saturated surface dry basis) shall be saturated with water before it is used. The wetting shall be performed sufficiently in advance to permit complete filling of the open pores of the particles of aggregate.

6. Concrete shall be uniformly plastic, cohesive, and workable. Workable concrete is defined as concrete which can be placed without honeycomb and without voids in the surface. Workability shall be obtained without producing a condition such that free water appears on the surface when finished. The consistency of the mixture shall be that required for the specified conditions and methods of placement; however, the previously determined maximum water cement ratio shall not be exceeded.

7. The properties of the concrete mixture will be determined by the Engineer to insure compliance with these specifications. Modifications will be made in the material proportions as are necessary to provide satisfactory concrete. The above properties will be determined by the following methods:

Slump	ASTM C143
Weight Per Cubic Foot, Yield	ASTM C138
Compressive Strength of Cylindrical Concrete Specimens	ASTM C39
Making and Curing Concrete Test Specimens in Field	ASTM C31
Air Content by Pressure Method	ASTM C231
Fly Ash in Portland Concrete Cement	ASTM C618

301.06 Proportioning of Materials.

All materials shall be separately and accurately measured by weight, and each batch shall be uniform. The coarse and fine aggregates shall be weighed separately. A sack of cement shall weigh ninety-four pounds (94#) (43kg). When bulk cement is used, ninety-four pounds (94#)

(43kg) shall be considered as one sack. The Contractor shall furnish and use approved weighing devices, which, in operation, will give the exact quantity of materials required for the class of concrete. When the cement is in contact with the aggregate, it shall not remain more than forty-five (45) minutes before being deposited into the mixer.

301.07 Measurement of Aggregate.

A. Where sack cement is used, the quantities of aggregate for each batch shall be exactly sufficient for one or more sacks of cement. No batch requiring a fraction of a sack of cement will be permitted. All measurements shall be by weight, upon approved weighing scales and shall be such as will insure separate and uniform proportions. Scales shall be of either beam or springless dial types, and shall be suitable for supporting the hopper or hoppers. They shall be set accurately in substantial mountings which will insure a permanent spacing of the knife edges under all conditions of loading and use. They shall be so designed and maintained that they will at all times be accurate to within one-half (1/2) of one (1) percent throughout the entire weight range. Clearance shall be provided between the scale parts and the hopper or the bin structure to prevent displacement of the scale parts due to vibrations, accumulations, or any other cause. The value of the minimum gradations on any scale shall not be greater than five pounds (5#) (2.3kg). The weighing beam or dial shall be so placed that it will be in full view of the operator during the operation of the gate which delivers the material to the hopper. Scales shall be protected from air currents that may affect the accuracy of weighing.

B. Separate hoppers shall be provided for weighing fine and coarse aggregate. They shall be of suitable size and tight enough to hold the aggregate without leakage, and shall be supported entirely upon the scales. Suitable provisions shall be made for removal of overload from the hopper by the operator while he operates the bin gates.

C. The Contractor shall provide a sufficient number of fifty-pound (50#) (23kg) standard test weights for calibrating the weighing equipment.

D. The volume of concrete mixed per batch shall not exceed the manufacturer's guaranteed capacity of the mixer.

E. When the aggregates are delivered to the mixer in trucks, each batch shall be in a separate compartment of the capacity required by the Engineer. Suitable covers shall be provided for the batch compartments of the trucks to protect the cement from the wind. All trucks, truck bodies, bulkheads, and compartments used in proportioning and transporting to the mixer of concrete materials shall be so designed and operated to insure the charging of the mixer, batch by batch, with the proper amounts of each material without overspillage, intermixing of batches or wastage. Any units which, in the opinion of the Engineer, do not operate satisfactorily, shall be removed from the work until properly rebuilt and corrected.

301.08 Mixing Concrete.

A. Consistency. The quantity of water to be used shall be determined by the Engineer and shall not be varied without his consent. The Contractor shall furnish and use with the mixer an approved adjustable, water measuring device which will prevent excess water flowing into the mixer, in order that the consistency may be under positive control and that all batches may be of the same consistency.

1. In general, the minimum amount of water shall be used which will produce the required workability. The mortar shall cling to the coarse aggregate and shall show no free water when removed from the mixer.

B. Mixer. The mixing machine used shall be of an approved type known as a batch mixer, and of a design having a suitable device attached for automatically measuring the proper amount of water accurate to one percent (1%) and for automatically timing each batch of concrete so that all materials will be mixed together for the minimum time required. Such device shall be easily regulated and controlled to meet the variable conditions encountered. If the time device becomes broken or fails to operate, the Contractor will be permitted to continue the balance of the day without the timing device while the same is being repaired, provided that each batch of concrete is mixed two (2) minutes.

1. The normal mixing time for each batch shall be one (1) minute, and the measuring of this period shall begin after all the materials are in the drum. During this mixing period, the drum shall revolve at the speed for which the mixer is designed, but shall make not less than fourteen (14) nor more than twenty (20) revolutions per minute.
2. No materials for a batch of concrete shall be placed in the drum of the mixer until the entire previous batch has been discharged therefrom. The discharge of water into the drum shall commence with the flow of the aggregates, but shall not be started before the entrance into the drum of part of the aggregates. The discharge of all of the mixing water for any batch shall be completed within ten (10) seconds after all of the aggregates are in the drum. The inside of the drum shall be kept free from hardened concrete.

3. The use of mixers having a chute delivery will not be permitted except by permission of the Engineer. In all such cases the arrangement of chutes, baffle plates, etc., shall be such as will insure the placing of fresh concrete without segregation.

4. Ready-mixed concrete from a central mixing plant delivered at the work ready for use, will be permitted, provided the mixture is transported to the job site in an agitating truck having the concrete contained in a revolving drum and provided there is no segregation of the mixture at the point of placing. Ready-mixed concrete from a central batching plant and mixed in transit will be permitted; however, the mixing and transporting equipment will be subject to the special approval of the Engineer. Any ready-mixed concrete shall comply with all of the requirements of these specifications. The concrete must be of workable consistency when placed. No mixer which has a capacity of less than a two-sack batch shall be used.

    i. Hand mixing will not be permitted except with the permission of the Engineer and then only in very small quantities or in case of an emergency.

5. In using air-entraining admixtures, the mixer shall be equipped with a suitable automatic dispensing device which will proportion the air entraining admixture accurately to each batch of concrete. The device shall be calibrated and adjusted to deliver to each batch of concrete the quantity of admixture required to produce the specified air content in the concrete.

6. The manufacturer of the concrete shall furnish to the purchaser with each batch of concrete before unloading at the site, a delivery ticket specifying information as outlined in Section 16.1 ASTM C94. The purchaser shall provide the Engineer with one (1) copy of each delivery ticket.

301.09 Protection.

It shall be the responsibility of the Contractor to protect from damage all freshly poured concrete regardless of the location or type of structure for a minimum period of seven (7) days or for such longer period as the Engineer may direct. Any concrete which is damaged shall be repaired to the satisfaction of the Engineer prior to acceptance of the completed work.

301.10 Quality Control Testing.

A. The Owner or Consultant will employ a testing laboratory to perform test and submit test reports. Test reports will be reported in writing to Consultant, Owner, and Contractor as soon as possible upon completion of tests.

1. Compressive Strength Tests. Concrete test cylinders will be made by a qualified technician from a certified material testing laboratory.

    i. The cylinders shall be made and tested in accordance with ASTM C39. One cylinder from each set shall be tested at 7 days and two from each set shall be tested at 28 days.

    ii. Tests may be required for each day's run or according to the following schedule:

Total Cubic Yards of Concrete Placed (m3)	Minimum Number of Tests* (3 cylinders each)
0 – 100 (0-75)	One for each 50 cu. Yds. (38m3)
100 – 1000 (75 -750)	One for each 125 cu. Yds. (100m3)
1000 – 2000 (750 – 1500)	One for each 175 cu. Yds. (125 m3)
2000 and Over (1500)	One for each 250 cu. Yds. (200 m3)

    *One test per pour minimum.

    iii. Results of all tests shall be furnished to the Engineer as soon as they are available.

2. Slump. Slump test shall be conducted in accordance with ASTM C172. A test shall be performed for each day's pour of each type of concrete and for each set of compressive strength test.

3. Air Content. Air content shall be tested in accordance with ASTM C143 or ASTM C231. Air content test shall be performed for each set of compressive strength tests of each type of air-entrained concrete.

SECTION 302
CONCRETE CURB, CURB AND GUTTER, CURBWALK, VALLEY GUTTERS, SIDEWALK, AND DRIVEWAYS

302.01 Description.

The work covered by this section consists of furnishing all equipment, labor, and materials necessary for constructing concrete curb, curb and gutter, curbwalk, valley gutters, sidewalks, and driveways on natural or prepared subgrades and bases, completed in accordance with the following specifications and dimensions shown on the plans.

302.02 Materials.

A. Portland Cement Concrete. Portland Cement Concrete shall conform to the requirements specified under Division 300, Section 301.

B. Reinforcing Steel and Fibers.

1. Reinforcing steel for concrete reinforcement shall meet the requirements of ASTM A615, Grade 60.

2. Welded wire fabric for concrete reinforcement shall meet the requirement as ASTM A185. Mesh shall be welded plain cold-drawn steel wire fabric.

3. Reinforcing Fibers. Concrete reinforcing fibers shall be polypropylene collated, fibrillated fibers designed and engineered specifically for use as secondary reinforcement for concrete, shall be three-quarter inch (3/4”) (20mm) to one inch (1”)(25mm) in length and be manufactured by Fibermesh Company, Forta Corporation, or approved equal.

C. Preformed Expansion Joint Material. Preformed joint material shall comply with the requirement of ASTM D994, ASTM D1751, or ASTM D1752.

D. Leveling Base Course. Base course materials, if specified, shall conform to the requirements of sand with less than 10% passing No. 200 sieve.

E. Forms. Concrete forms shall be wood, steel, or other suitable material of size and strength to resist movement during concrete placement and to retain horizontal and vertical alignment until removal. Forms shall be coated with a non-staining agent that will not discolor or deface surface of concrete.

F. Curing Compound. Curing compound shall be poly-alpha-methyl-styrene (PAMS) meeting AASHTO 148 Class B, or engineer approved equivalent.

G. Foundation Material. Refer to Division 600, Section 602.

H. Aggregates. Course and fine Aggregates shall meet the requirements of ASTM C33 and Article 2. Concrete mix under this Section shall meet one and one half inch (1½") (37.5 mm) sieve size, as specified in Division 300, Section 301.

302.03 Subgrade and Base.

A. Natural Subgrades.

1. The subgrade shall be cut to a depth below finish grade sufficient to accommodate the thickness of a leveling base course and concrete specified. The upper eight inches (8") (200mm) of the subgrade shall be compacted to a dry density of at least 95% of maximum dry density as determined by ASTM D698 at a moisture content of + 2% OF optimum. The finished surface of the subgrade shall be smooth, free from surface irregularities, and true to line and grade as established by grade hubs or pins.

2. Compaction tests shall be performed a minimum of every one hundred fifty feet (150') (45m) of curb walk or side walk, once for each valley gutter, and once for each driveway not part of a section of curb walk being tested.

3. Trenches crossing curbwalk, valley gutters, or other concrete paving within the City right-of-way shall be compacted the full depth of the trench in accordance with Division 601.06. This applies to all trenches installed for any purpose.

B. Prepared Subgrades with Select Backfill.

1. Where spongy, organic, or otherwise unsuitable material is encountered, which, in the opinion of the Engineer is unsuitable for subgrade, such unsuitable material shall be removed to a minimum of twelve inches (12") (300mm) below the four inch (4") (100mm) thick leveling base course, and replaced with foundation material. The Engineer may direct the Contractor to excavate deeper than the specified twelve inches (12") (300mm). All select backfill material shall be compacted to 95% of maximum dry density, as determined by ASTM D698 at a moisture content of + 2% of optimum. Any boulders encountered shall be removed. Tree roots shall be removed at least one foot (1') (300mm) laterally and twelve inches (12") (300mm) vertically below all prepared subgrades.

C. Proof Rolling

Subgrades shall be proof rolled after compaction testing requirements have been passed and prior to placement of the leveling base course. Proof rolling shall be performed in the presence of the Engineer and a representative of the City Engineer's office.

D. Leveling Base Course.

1. Just prior to placement of concrete, the four inch (4") (100mm) thick leveling base course shall be accurately graded to conform to the grade of the forms, and sprinkled if necessary until the moisture content is at or near optimum moisture content. Optimum moisture content shall be determined by the Engineer in accordance with ASTM D698. In no case shall concrete be placed on a saturated base or if free water is standing on the base.

302.04 Forms.

A. All forms shall be of wood or metal, straight, free from warp, and of sufficient strength when staked to resist the pressure of the concrete without springing, and the upper edge shall form a

true line. Outside forms for the curbwalk shall be of a depth equal to the full depth of the sidewalk, and the inside forms shall be of the depth of the gutter and shall be so designed as to permit secure fastening to the outside form. All forms shall be cleaned thoroughly and greased or oiled before concrete is placed against them. Forms that have become worn, bent, or broken shall not be used. Forms shall be securely set true to line and grade.

B. On short radii curves, steel plates, which can be readily formed to the desired radii, shall be used. Face forms, if used, shall be preshaped to the proper radii. Care shall be exercised to insure the maintenance of the required cross-section around the entire radius.

C. The Contractor shall provide an approved metal straight edge, ten feet (10') (3m) in length for use in checking the alignment of the forms prior to placing the concrete and also to check the concrete surface during the finishing operation. Forms and the final product shall not deviate more than one-quarter inch (1/4") (6.25mm) from a straight edge ten feet (10') (250mm) in length and shall be sloped to achieve complete drainage without "bird baths."

D. Forms shall remain in place at least twelve (12) hours after concrete has been placed against them or for a longer period if so directed by the Engineer. Crowbars or other heavy tools shall not be used against green concrete in removing the forms. Forms shall be well cleaned before reoiling and reuse.

E. Screed guide templates shall be pulled prior to the concrete taking initial set. In those cases where initial set takes place prior to pulling of the templates, the joint shall be sealed with an asphaltic sealing compound approved by the Engineer.

302.05. Protection.

Protect fresh concrete from deleterious effects of weather and from traffic until adequately cured. Concrete shall not be placed on frozen subgrade or when weather is stormy, dusty, or otherwise inclement to the point that it precludes good workmanship. Air temperature shall be a minimum of 40° F (40C) and rising when the pour is started. Adequate measures shall be employed to protect the concrete from freezing for a period of at least seventy-two (72) hours after it is poured. Concrete may be placed when air temperature is below 40o F if conditions stated in the Section 513.4.2 of the Standard Specifications for Road and Bridge Construction, Wyoming Department of Transportation, 2003 Edition are followed.

302.06. Joint Construction.

A. Expansion Joints. All expansion joints shall be constructed straight, plumb, and shall extend through the full width and depth of the section. Expansion joint material shall be flush with the finished surface to three-quarters inch (3/4") (20 mm) below the finished surface. Edges adjacent to expansion joint material shall be tooled. Expansion joints shall be constructed at the intersection with any existing curbwalk or curb and gutter, at the tangent point of curb radii, at alley returns, and at intermediate intervals of not more than sixty feet (60') (18m) or at such lesser spacing as may be determined by the Engineer.

B. Contraction Joints. Transverse weakened-plane contraction joints shall be constructed at right angles to the curb line at intervals of five feet (5') (1.5m). Joint depth shall average at least one-fourth (1/4) of the cross- section of the concrete.

1. Contraction joints may be sawed, handformed, or made by one-eighth inch (1/8") (3mm) thick division plates in the formwork. Sawing shall be done early after the concrete has set to prevent the formation of uncontrolled cracking. The joints may be handformed either by:

    i) using a narrow or triangular jointing tool or a thin metal blade to impress a plane of weakness into the plastic concrete.

    ii) inserting one-eighth inch (1/8") (3mm) thick steel strips into the plastic concrete temporarily. Steel strips shall be withdrawn before final finishing of the concrete.

2. After removal of templates and finishing, contraction joints shall be reopened with a mason's trowel to a depth of one-fourth (1/4) the thickness of the section, the line of cut coinciding with and extending into the joint formed by the template. The joints shall be finished with a jointer.

C. Construction Joints. At end of day's run, or in case of an interruption which would result in cold joint, construction joints shall be made at right angles to the longitudinal axis of the curbwalk and shall be located at the regular five foot (5') (1.5m) spacing designated for contraction joints unless otherwise specifically permitted by the Engineer. In no case shall any length of curbwalk be less than five feet (5') (1.5m) between joints.

1. Construction joints shall be formed by use of a bulkhead or divider which shall be removed before continuing with the next run. Edges of construction joints shall be edge tooled to form a recess for sealing compound.

302.07. Concrete Placement.

A. Concrete shall be placed either by an approved slipform/extrusion machine, by the formed method, or by a combination of these methods. Concrete shall not be placed until base courses and forms have been checked for depth and alignment. The method used shall adequately vibrate and compact the concrete to achieve a homogeneous dense concrete free from honeycomb and pockets of segregated aggregate.

B. Machine Placement. The slipform/extrusion machine approved shall be so designed as to place, spread, consolidate, screed, and finish the concrete in one complete pass in such a manner that a minimum of hand finishing will be necessary to provide a dense and homogeneous concrete section. The machine shall shape, vibrate, and/or extrude the concrete for the full width and depth of the concrete section being placed. It shall be operated with as nearly a continuous forward movement as possible. All operations of mixing, delivery, and spreading concrete shall be so coordinated as to provide uniform progress, with stopping and starting of the machine held to a minimum.

C. Formed Method. Construct forms to the shape, lines, grades, and dimensions called for in the Drawings. Set wood or steel forms securely in place, true to line and grade. Forms shall be braced to prevent change of shape or movement in any direction resulting from the weight of the concrete during placement. Tops of forms shall not depart from grade line more than one-fourth inch (1/4") (6.25mm) when checked with a ten-foot (10') (3m) straightedge. Alignment of straight sections shall not vary more than one-fourth inch (1/4") (6.25mm) in ten feet (10') (3m).

302.08. Finishing.

A. Finishing shall be done with a metal screed or mule designed to give proper shape to the section as detailed. Particular care shall be used to finish the gutter flow line to a true, uniform grade that will drain completely without “bird baths”. The back of the curbwalk and toe of the gutter shall be edge tooled. Traffic surfaces shall be broom finished at 90o to the direction of traffic. All honeycombed areas or small defects shall be patched with 1:2 mix mortar.

B. After stripping forms, exposed concrete surfaces shall be finished smooth and even by means of a moist wood float or a moist brick.

C. Sides of concrete exposed by the removal of forms shall be protected immediately to provide continuance of curing and preventing injury to the edge and the underlying subgrade. After the forms have been removed, suitable fill material shall be placed along the edge of the walk and tamped by either hand or mechanical tampers to a density at least equal to that of the adjacent ground. The finish grade and section shall be as indicated on the drawings and to the satisfaction of the Engineer.

302.09 Curing

Concrete shall be sprayed uniformly with curing compound immediately after finishing of the surface and before the set of the concrete has taken place. Curing compound shall be applied at the manufacturer’s recommended rate. Curing compound shall also be applied immediately to the exposed concrete once forms have been removed. See section 302.02 for approved curing compounds.

302.10 Jointing New and Existing Curb Sections.

Where the new curbwalk sections will join existing curb or curbwalk with a different cross-section, a five foot (5') (1.5m) long minimum transition section shall be constructed.

302.11 Fiber Reinforced Concrete.

Where specified or approved by the Engineer, provide polypropylene fibers added to the concrete mix to control shrinkage cracks. Polyproplyene fibers shall be added at the rate of three pounds (3#) (1.4kg) of fiber per cubic yard of concrete. Fibers shall be added to the concrete in accordance with the manufacturer's recommendations.

302.12 Standard Detail Section (See Attachment A)

302/1 Standard Curbwalk Details for Existing Construction
302/2 Standard Curbwalk and Sidewalk Details
302/3 Standard Pathway Sections
302/4 Typical Concrete Curb and Gutter Section
302/5 Typical Concrete Curb and Gutter Section
302/6 Typical Curb Cut Section for Existing Construction
302/7 Driveways, Approaches & Median Cuts for ADA Accessibility
302/8 Standard Valley Gutter Sections
302/9 General Sidewalk Requirement for ADA Accessibility
302/10 Type I Perpendicular Curb Ramps for ADA Accessibility
302/11 Type II and Type III Curb Ramps

302.13 Cutting and Patching of Asphalt Paving.

When curb cuts, curb walk, or other concrete structures are installed adjacent to existing asphaltic concrete paving, the asphalt paving shall be saw cut parallel to and a minimum of eighteen inches (18") (450mm) away from the edge of the concrete. The excavation between the concrete and the asphalt paving shall be backfilled with a minimum of four inches (4") (100mm) of asphalt placed and compacted in two lifts over a minimum of six inches (6") (150mm) of compacted grading "W" base course. Base course and asphaltic concrete paving shall comply with City of Casper standard specification. Where the existing pavement and base course sections exceed the minimums specified above, the replacement thickness shall match the existing.

302.14 Colored Concrete

Colored concrete shall match the color of the concrete installed for curb ramps for ADA accessibility on other City projects. The color required is Solomon No. 489 Maroon dye added to City of Casper standard six (6) sack, 4,000 psi mix at a rate of 25 pounds per cubic yard.

DIVISION 400

SECTION 402
PAVEMENT BASE COURSE

402.01 Description.

The work covered by this Section shall consist of furnishing, placing, watering, shaping, and compacting a course or courses of crushed gravel to provide a firm and stable foundation for subsequent construction. The base course shall be constructed on a previously constructed subbase or subgrade in accordance with the requirements of these specifications and in conformity with the lines, grades, quantity requirements, and the typical cross-sections shown on the plans.

402.02 Materials.

A. Crushed Gravel. The crushed gravel for base course shall consist of clean, hard, durable particles which have been crushed to the following gradations:

Sieve Size	% Passing by Weight	
	Grading W	Grading H
1 1/2" (37.5mm)	100	
1" (25mm)	90-100	100
1/2" (12.5mm)	60-85	95-100
#4(4.75mm)	45-65	45-65
#8 (2.36mm)	33-53	33-53
#200 (75*u*m)	3-12	3-12

1. The above is equivalent to Wyoming Highway Department grading "W" or grading "H" base course. The type of base course to be applied shall be specified in the special provisions.

2. Coarse aggregate shall consist of hard, durable particles, or fragments of stone or gravel. Materials that break up when alternately frozen and thawed or wetted and dried shall not be used. Unless otherwise specified, the coarse aggregate shall have a percentage of wear of not more than 50%.

3. Fine aggregate shall consist of crushed stone, crushed gravel, or natural sand. The fraction passing the No. 200 (75*u*m) sieve shall not be greater than two-thirds (2/3) of the No. 40 (425*u*m) sieve. The fraction passing the No. 40 (425*u*m) sieve shall have a liquid limit not greater than twenty-five (25) and a plasticity index not greater than six (6) except that, when the plasticity index is non-plastic, the liquid limit shall not be more than thirty (30).

4. Of the particles retained on a No. 4 (425*u*m) sieve, at least 35% by weight shall have one (1) or more broken faces.

B. Preconstruction Testing. All testing and sampling shall be done in accordance with latest ASTM methods, unless otherwise specified. At least two (2) weeks in advance of the beginning of base work, the Contractor shall:

1. Submit suitable samples of the base material to an approved materials testing laboratory for tests to determine the compliance of the proposed subbase material with these Specifications;

2. Or shall submit certification that the materials to be used are in conformance with these Specifications.

C. Construction Testing. During construction the supplier/Contractor shall have performed by an approved testing laboratory one (1) gradation test including liquid limit and plasticity index per each five thousand tons (5,000t) (4500 metric t) or portion thereof, of base material.

1. The results of such tests shall be submitted by the lab to the Engineer, Contractor, and owner.

402.03 Mixing.

A. The crushing plant shall be equipped with rolls, or any combination of rolls, jaws, or other crushing devices, which will produce the required material. Care shall be exercised in the operation of loading, hauling, and distributing the crushed material to avoid segregation of the coarse and fine particles of the total material. If segregation occurs, the method of spreading and placing shall be modified so that placement is made to the satisfaction of the Engineer. The base course shall be placed on the previously prepared subbase or base course in the proper quantities to conform to the typical cross-section shown on the plans. The crushed material shall then be windrowed and watered as directed by the Engineer and mixed until a uniform mixture is obtained.

1. The base course thickness specified by the plans is absolute minimum thickness. Where the subbase has been left low, the Contractor may, at his option, use base course material as covered in this section of specifications to bring the subbase up to the grade specified.

2. The Contractor shall mix the aggregate, water, and commercial additive where required, by the stationary plant methods unless otherwise shown on the plan or approved by the Engineer. The moisture content of the material at the time of compaction shall be within +2 or -4 percentage points of optimum.

B. Stationary Plant Method. The aggregate and water shall be mixed in an approved pugmill mixer. Water shall be added during the mixing operation in the amount necessary to maintain the required moisture content for compacting.

1. The mixer shall be capable of uniformly distributing the aggregate, additives, and water throughout the mixture without evidence of overwet or dry pockets of material when the equipment is operated at the Contractor's desired capacity.

2. After mixing, the material shall be transported to the job site while it contains the proper moisture content, and shall be placed on the roadbed by means of an approved aggregate spreader.

3. The spreader shall be capable of spreading the material for a minimum width of ten feet (10') (3m) when used to full capacity to a uniform thickness.

C. Travel Plant Method. After the material for each layer has been placed through an aggregate spreader, window sizing device or aggregate hopper, the material shall be uniformly mixed by a traveling mixing plant. During mixing, water shall be added in an amount sufficient to maintain the required moisture content for compacting.

D. Road Mix Method. After material for each layer of the course has been placed, the materials shall be mixed while in the range of +2 or -4 percentage points of optimum moisture content, by means of motor graders or other approved equipment until the mixture is uniform throughout.

E. Stockpile Method. Commercial additives, if required, will be introduced into the aggregate during stockpiling operations. Water will be introduced by pre-wetting the stockpile of aggregate and additive. Additional water may have to be introduced during the placing of the aggregate courses.

402.04 Shaping and Compaction.

A. After the base course material has been placed and uniformly spread over the prepared subbase, compaction shall be accomplished by means of multiple-wheel, pneumatic-tired rollers, tandem or three-wheel steel rollers and/or vibratory compactors, or any other method approved by the Engineer. If additional water is needed to facilitate compaction and bonding of materials, it shall be applied at the direction of the Engineer. Rolling shall be continued until the entire base course has been compacted to the required density and moisture content.

1. The finished base surface shall be smooth and free of ruts and irregularities and true to grade and crown and thickness as shown by the plans or directed by the Engineer.

2. Each layer shall be compacted to a density of not less than 95% of maximum density and a moisture content of plus or minus 2% of optimum moisture, as determined in accordance with ASTM D698, unless otherwise called for on the plans. Compactions or field-in-place densities will be determined by sand cones or nuclear density meters. The surface of each layer shall be maintained during the compaction operations in such a manner that a uniform texture and surface is produced and the aggregates firmly keyed. Water shall be uniformly applied over the materials during compaction in the amount necessary for proper consolidation.

3. If the required compacted depth of subbase course exceeds six inches (6")(150mm), the course shall be constructed in two or more layers of approximately equal thicknesses. The maximum compacted thickness of any one layer shall not exceed six inches (6")(150mm). When vibrating or other approved types of special compacting equipment are used, the depth of a single layer of the course may be increased upon approval by the Engineer.

402.05 Quality Control Testing.

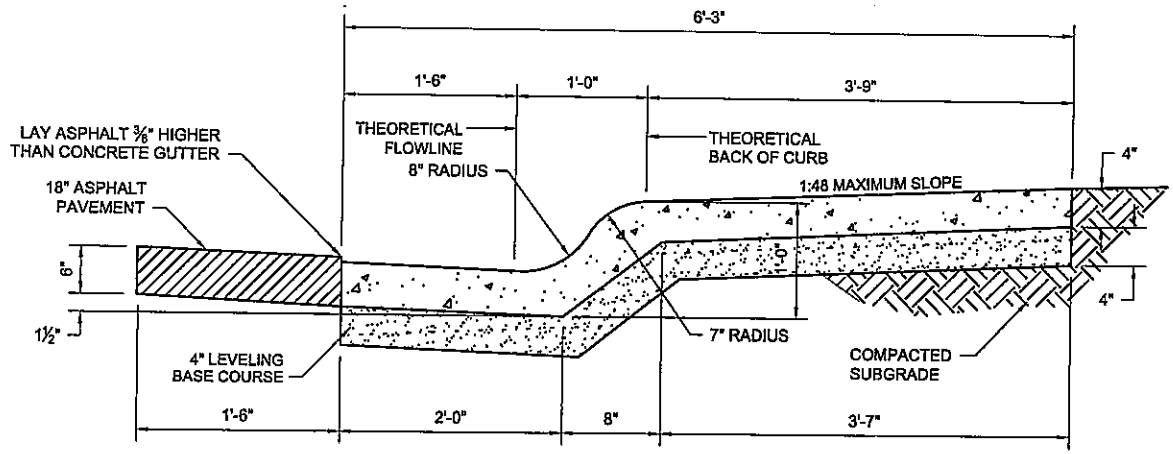
A. One density and moisture test shall be performed for every two thousand square yards (2,000 sq.yds) (1675 sq.m) of base course placed.

B. Gradation tests, including liquid limit and plasticity index shall be performed for every two thousand square yards (2,000 sq.yds) (1,675 sq.m.) placed, or portion thereof.

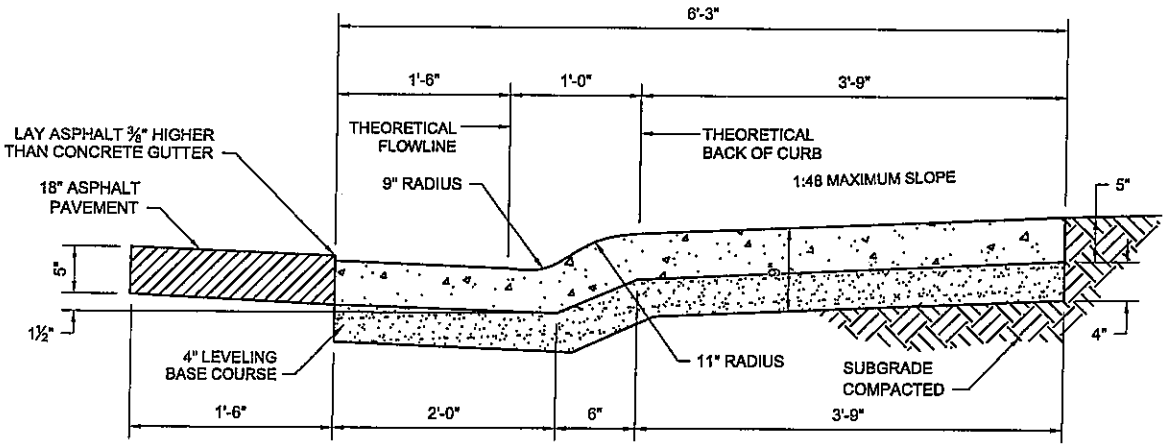
C. The Contractor/Supplier shall select and pay for a certified testing firm, acceptable to the Owner and Engineer to complete all gradation, liquid limit and plasticity index testing requirements, prior to and during construction. The lab shall forward copies of the results of such tests to the Engineer, Contractor, and/or Owner.

Attachment A

Standard Details



EXISTING RIGHT-OF-WAY CONSTRUCTION
STANDARD CONCRETE CURBWALK



EXISTING RIGHT-OF-WAY CONSTRUCTION
STANDARD CONCRETE CURBWALK
(ALTERNATE PROFILE DETAIL)

NOTES:

1. CUT AND REMOVE EXISTING ASPHALT 18" BACK FROM LIP OF GUTTER. PLACE GRADING "W" BASE COURSE, BACKFILL AND COMPACT TO TOP ASPHALT ELEVATION. EXCEPTIONS MAY BE GRANTED BY CITY ENGINEERING.

2. THE CITY OF CASPER DOES NOT PAVE BACK THE 18" CUT BACK FOR COMMERCIAL PROPERTIES, SITE PLANS, SUBDIVISION DEVELOPMENT, NEW CONSTRUCTION, ETC.

STANDARD CURBWALK DETAILS FOR EXISTING CONSTRUCTION

NOT TO SCALE

CITY OF CASPER
ENGINEERING DIVISION

STANDARD CURBWALK DETAILS FOR EXISTING CONSTRUCTION

302/1

REV.	DESCRIPTION	DATE
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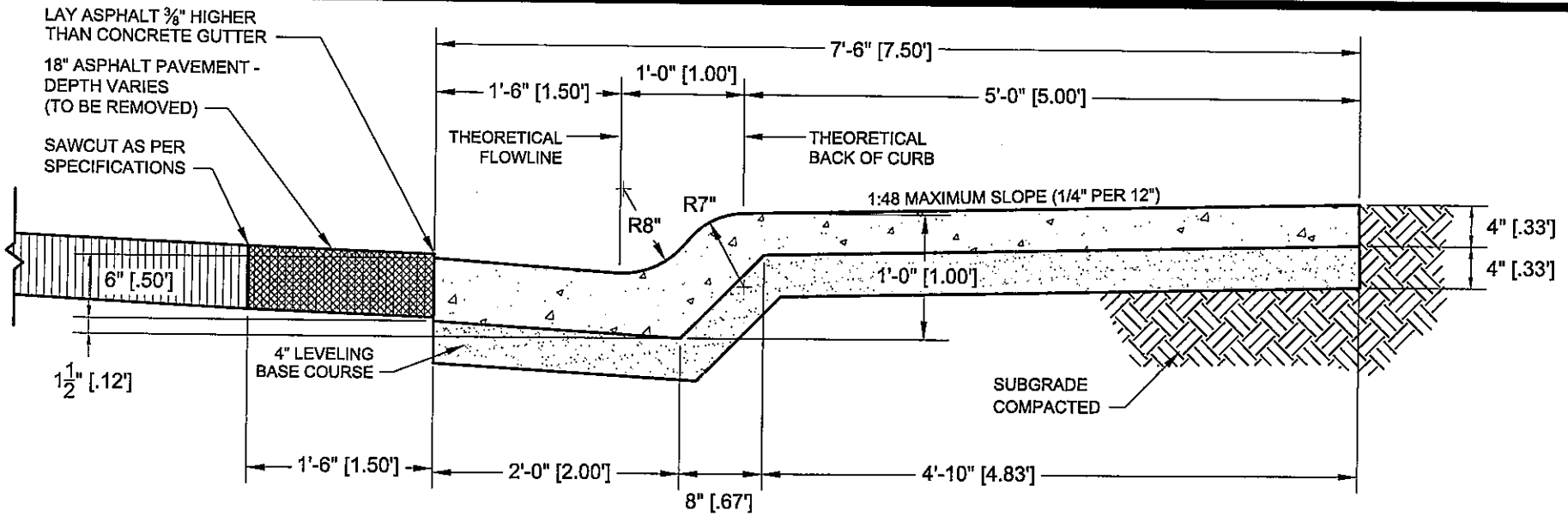
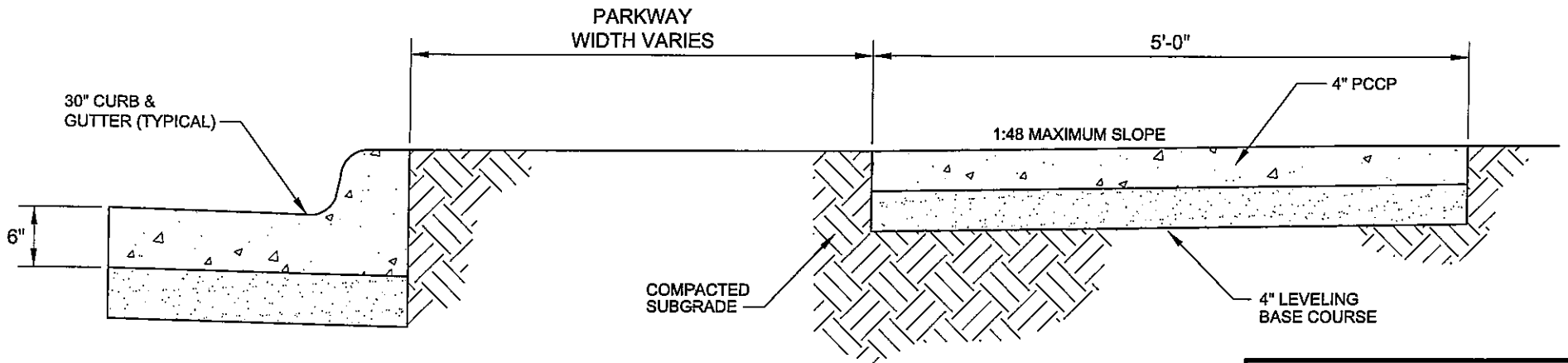
2	DRAWING STANDARDS REVISIONS	JAN 06



NEW RIGHT-OF-WAY CONSTRUCTION
STANDARD CONCRETE CURBWALK
(ALTERNATE PROFILE DETAIL)



NEW RIGHT-OF-WAY CONSTRUCTION
STANDARD CONCRETE CURB AND SIDEWALK

CITY OF CASPER
ENGINEERING DIVISION

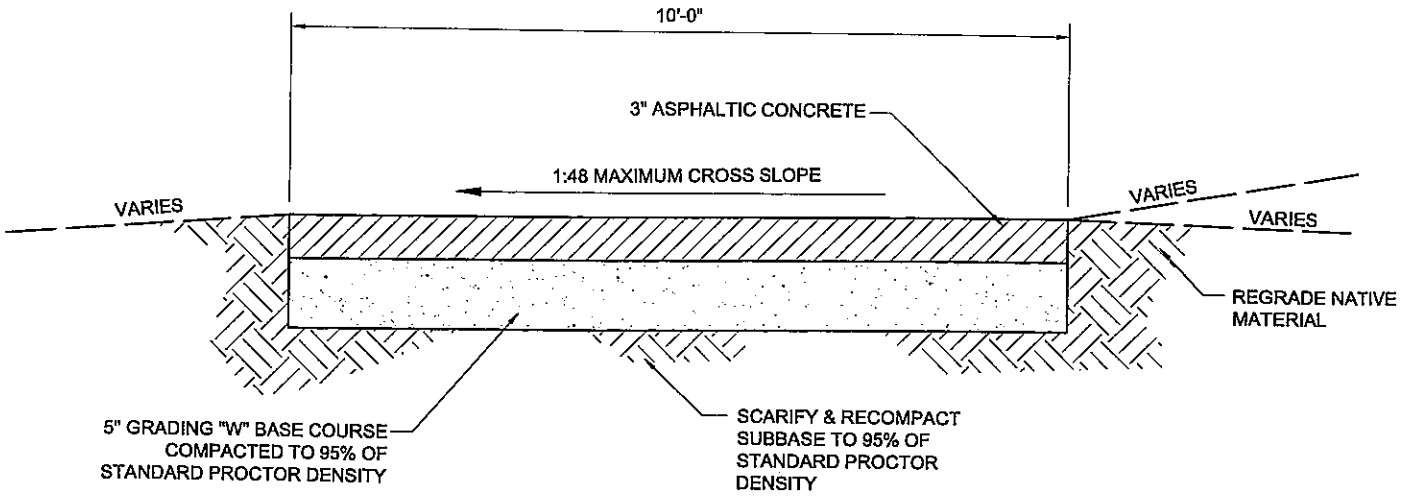
STANDARD CURBWALK AND SIDEWALK DETAILS

302/2

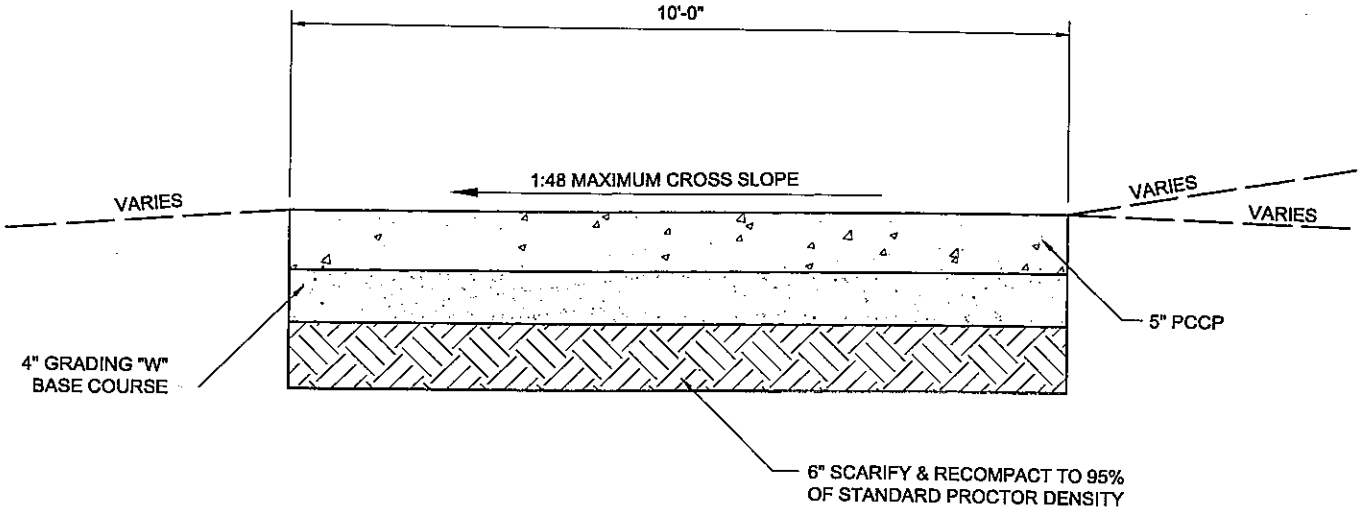
REV.	DESCRIPTION	DATE
1	REDRAFTED ONTO COMPUTER- Z.T.L.	5/5/01
2	DRAWING STANDARDS REVISIONS	JAN 06

STANDARD CURBWALK AND SIDEWALK DETAILS

NOT TO SCALE



STANDARD ASPHALT PATHWAY SECTION



STANDARD CONCRETE PATHWAY SECTION

STANDARD PATHWAY SECTIONS

NOT TO SCALE

NOTE:

5' CONCRETE PATHWAY TYPICAL SECTION SHALL CONSIST OF 4" PCCP AND 4" BASE COURSE.

CITY OF CASPER ENGINEERING DIVISION

STANDARD PATHWAY SECTIONS

302/3

REV.	DESCRIPTION	DATE
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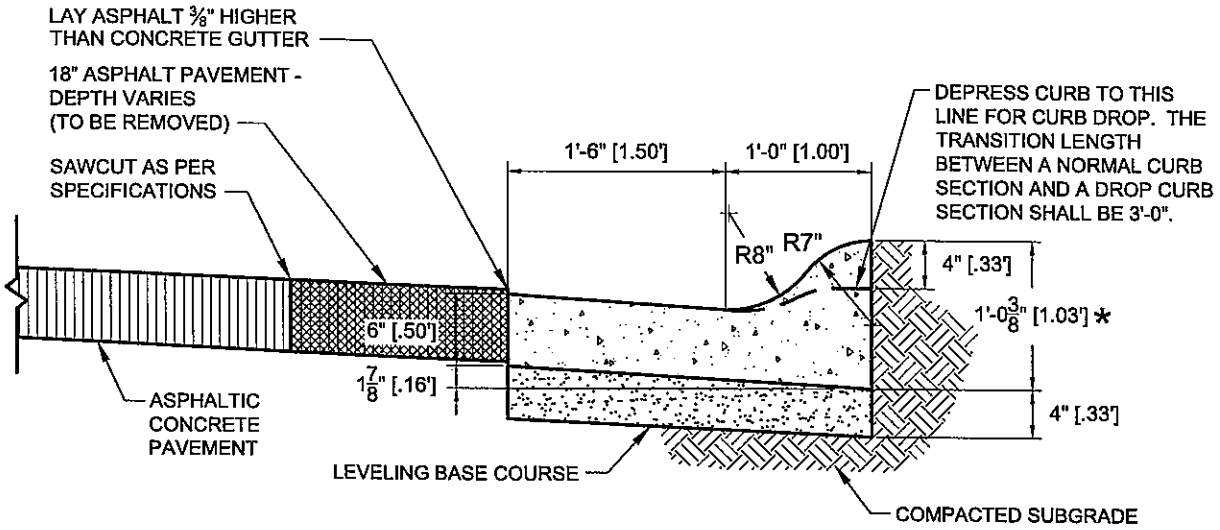
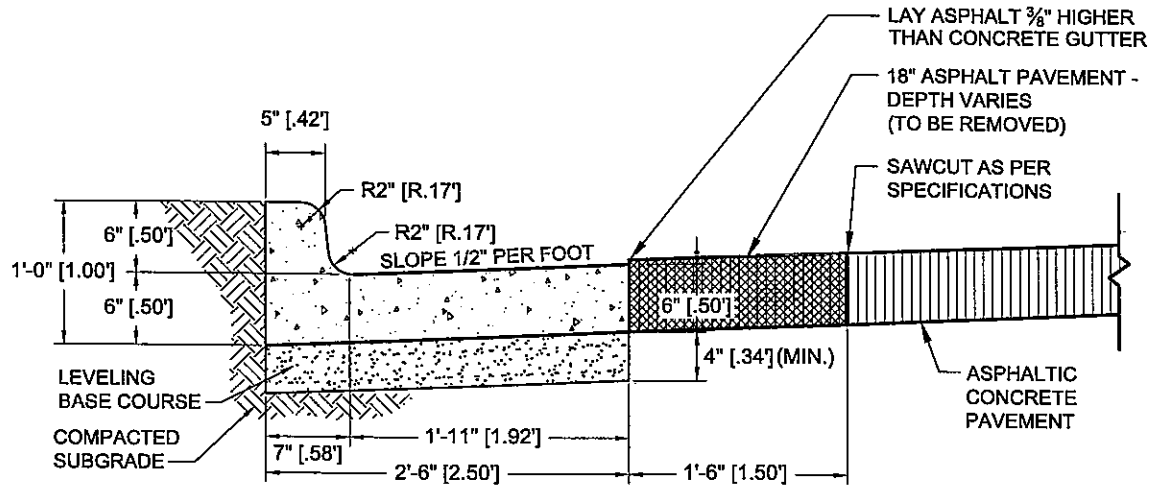
2	DRAWING STANDARDS REVISIONS	JAN 06



30" CONCRETE CURB & GUTTER TYPE A



30" CONCRETE CURB & GUTTER TYPE B

TYPICAL CONCRETE CURB & GUTTER SECTIONS

NOT TO SCALE

CITY OF CASPER ENGINEERING DIVISION

STANDARD CURBWALK DETAILS FOR EXISTING CONSTRUCTION 302/4

REV.	DESCRIPTION	DATE
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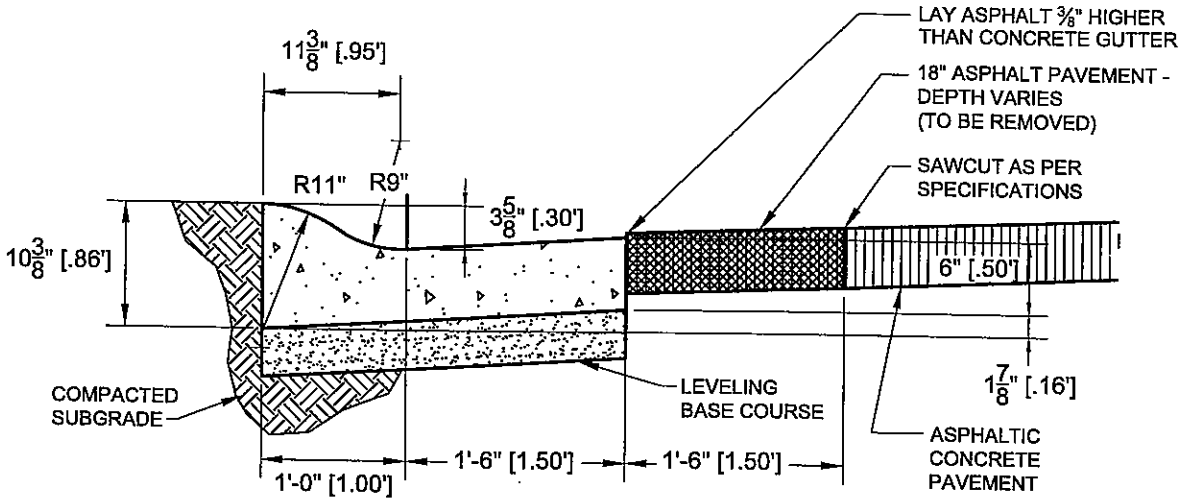
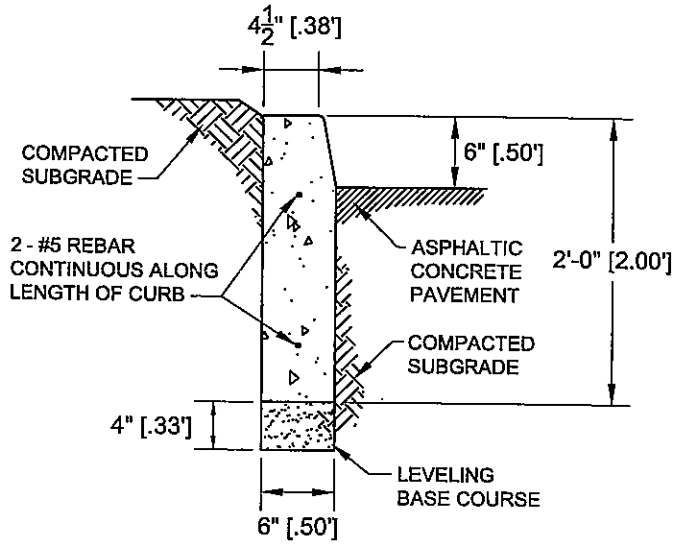
2	DRAWING STANDARDS REVISIONS	JAN 06



TYPE A-1
30" CONCRETE CURB & GUTTER



VERTICAL 24" CONCRETE CURB & GUTTER

TYPICAL CONCRETE CURB & GUTTER SECTIONS

NOT TO SCALE

CITY OF CASPER
ENGINEERING DIVISION

STANDARD CURBWALK DETAILS FOR EXISTING CONSTRUCTION

302/5

REV.	DESCRIPTION	DATE
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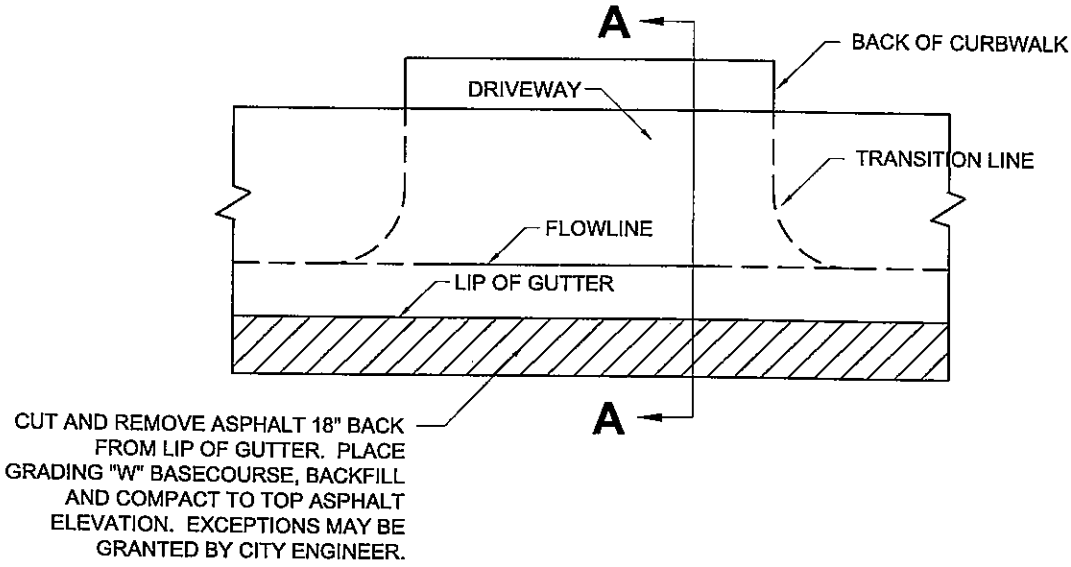
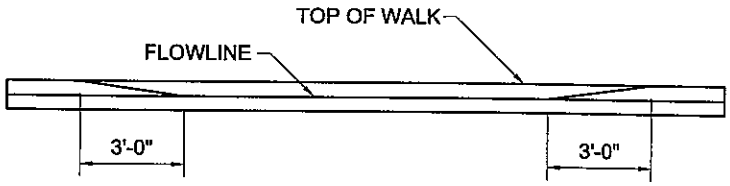
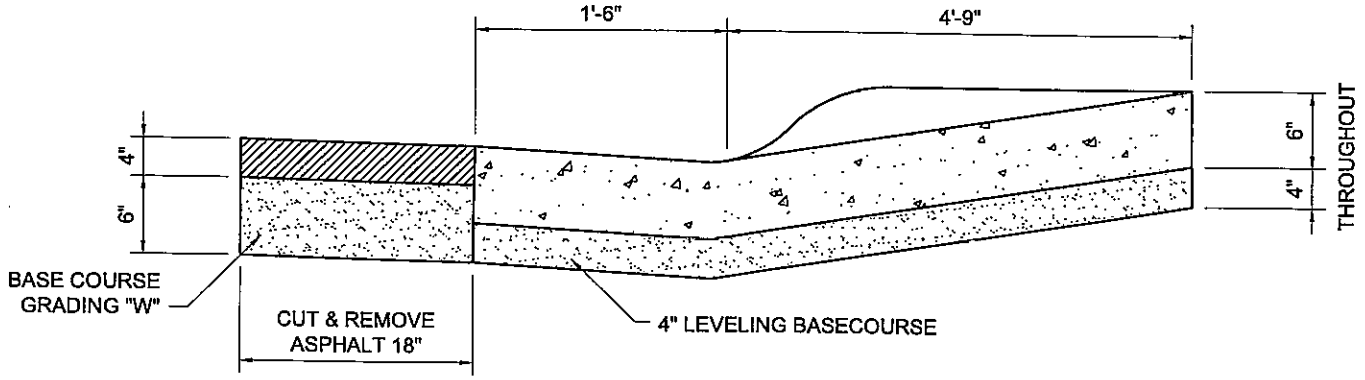
2	DRAWING STANDARDS REVISIONS	JAN 06



CURBWALK PLAN AT DRIVEWAY



ELEVATION



SECTION A-A

TYPICAL CURB CUT SECTION FOR EXISTING CONSTRUCTION

NOT TO SCALE

NOTES:

1. REINFORCING FOR DRIVEWAY SECTIONS SHALL CONSIST OF NO. 3 REBAR AT 18" ON CENTER EACH WAY OR FIBER-REINFORCED CONCRETE.

2. THE CITY OF CASPER DOES NOT PAVE BACK FOR COMMERCIAL PROPERTIES, SITE PLANS, SUBDIVISION DEVELOPMENT, NEW CONSTRUCTION, ETC.

CITY OF CASPER
ENGINEERING DIVISION

TYPICAL CURB CUT SECTION FOR EXISTING CONSTRUCTION

302/6

REV.	DESCRIPTION	DATE
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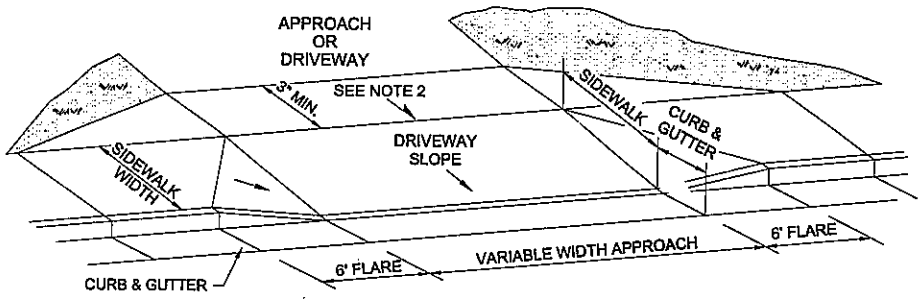
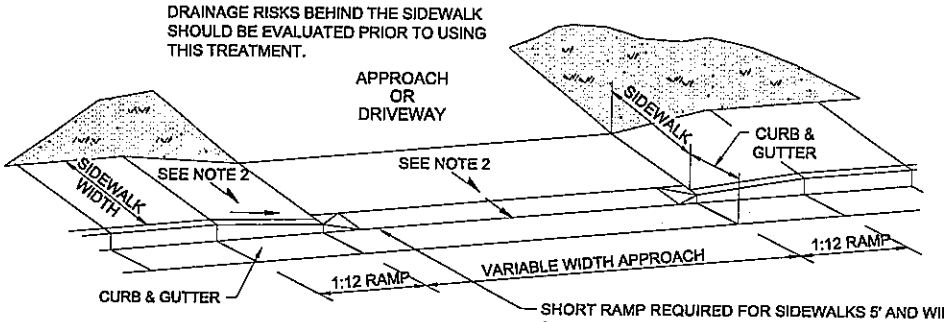
2	DRAWING STANDARDS REVISIONS	JAN 06



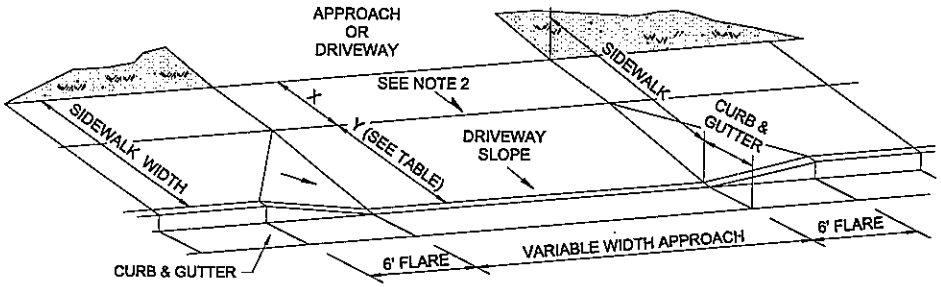
PEDESTRIAN SIDEWALK WITH EXTERNAL BYPASS

(PREFERRED APPROACH FOR SIDEWALK ADJACENT TO CURB AND WHERE RIGHT-OF-WAY PERMITS CONSTRUCTION)



DEPRESSED PEDESTRIAN SIDEWALK

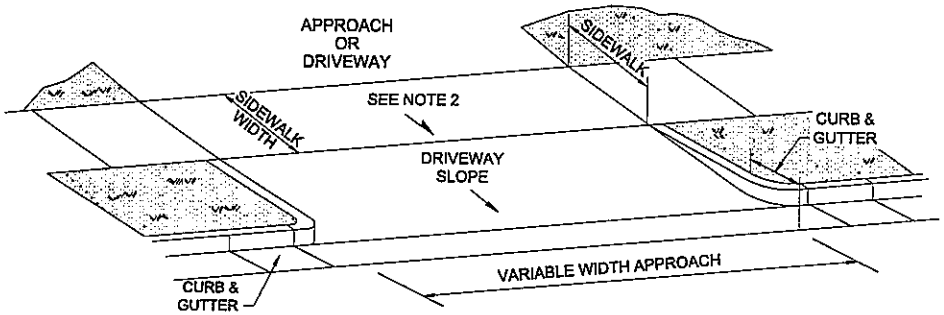
(DESIRABLE APPROACH WHEN DRAINAGE BEHIND SIDEWALK IS NOT A PROBLEM



PEDESTRIAN SIDEWALK WITH INTERNAL BYPASS

(DESIRABLE TO USE WITH SIDEWALK WIDTHS 8' AND WIDER, BUT ACCEPTABLE FOR NARROWER SIDEWALKS WHEN EXTERNAL BYPASS OR DEPRESSED SIDEWALK IS NOT FEASIBLE DUE TO AVAILABLE RIGHT-OF-WAY OR DRAINAGE CONCERNS)

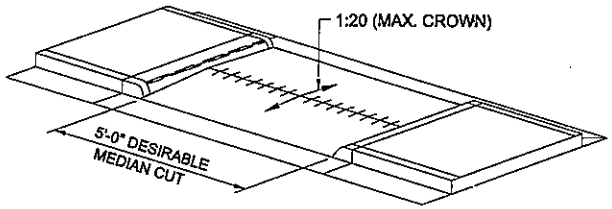
SIDEWALK WIDTH	X	Y
5'	3'	2'
6'	4'	2'
7'	4'	3'
8'	4'	4'
9'	4.5'	4.5'
>9'	VARIES	5'



DETACHED PEDESTRIAN SIDEWALK

(MOST DESIRABLE TREATMENT)

TYPICAL SIDEWALK AND/OR DOUBLE GUTTER TREATMENT AT APPROACHES



MEDIAN OR ISLAND CUT

NOTES:

1. **RAMP SLOPE:** RAMP SLOPE SHALL BE 1:12. RAMP SLOPE SHALL NOT EXCEED 1:12.
2. **CROSS SLOPE:** POSITIVE DRAINAGE SHALL BE PROVIDED BY SLOPING SIDEWALK AND/OR RAMP TOWARDS THE STREET AT 1:48. CROSS SLOPE SHALL NOT EXCEED 1:48.

DRIVEWAYS, APPROACHES AND MEDIAN CUTS

NOT TO SCALE

CITY OF CASPER
ENGINEERING DIVISION

DRIVEWAYS, APPROACHES & MEDIAN CUTS FOR ADA ACCESSIBILITY

302/7

REV.	DESCRIPTION	DATE
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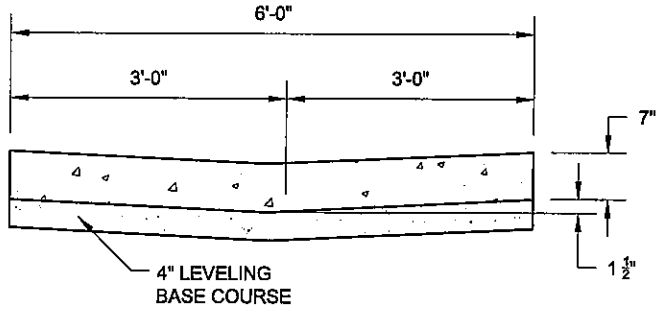
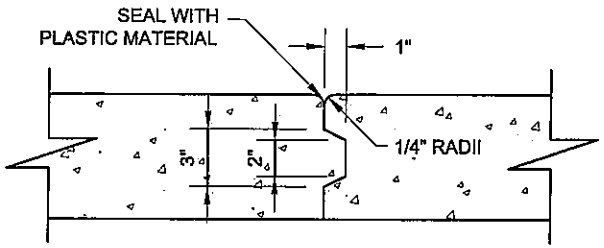
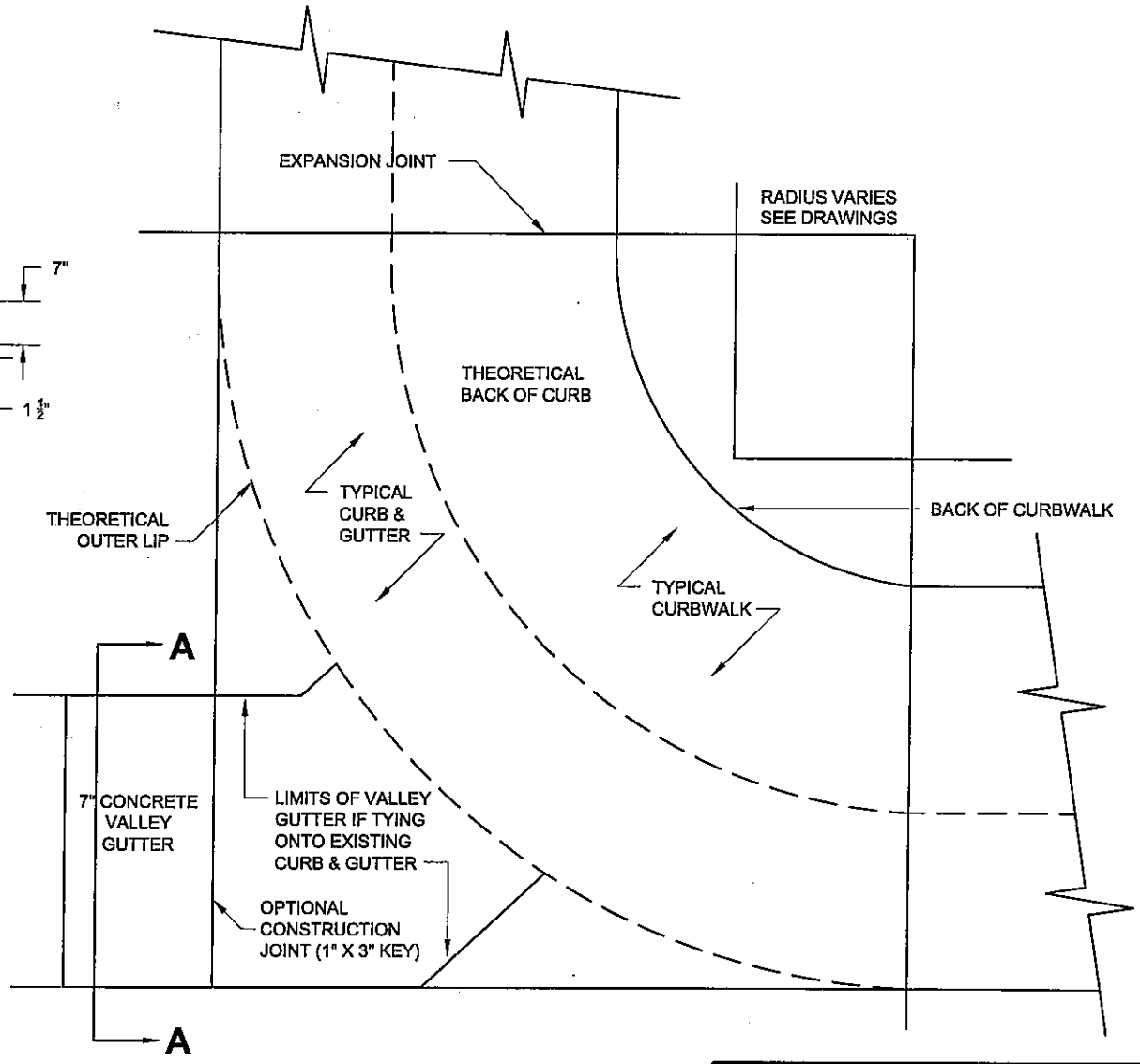
2	DRAWING STANDARDS REVISIONS	JAN 06



SECTION A-A



TYPICAL KEYED CONSTRUCTION JOINT



STANDARD VALLEY GUTTER SECTIONS

NOT TO SCALE

NOTES:

1. RADIUS LENGTH SHALL BE AS SPECIFIED IN SUBDIVISION ORDINANCE.

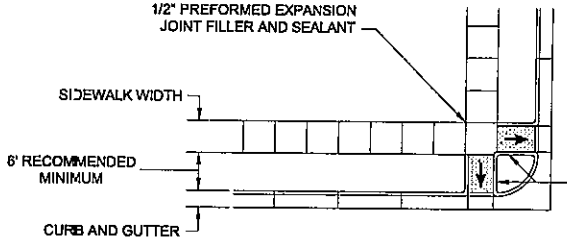
2. VALLEY GUTTERS SHALL BE REINFORCED WITH WWF 4 X 4 X W4 X W4 OR POLYPROPYLENE FIBERS OR #3 REBAR AT 18" ON CENTER EACH WAY.

CITY OF CASPER
ENGINEERING DIVISION

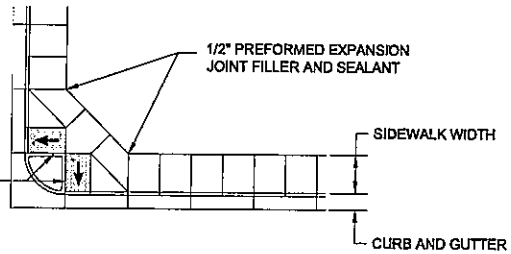
STANDARD VALLEY GUTTER SECTIONS

302/8

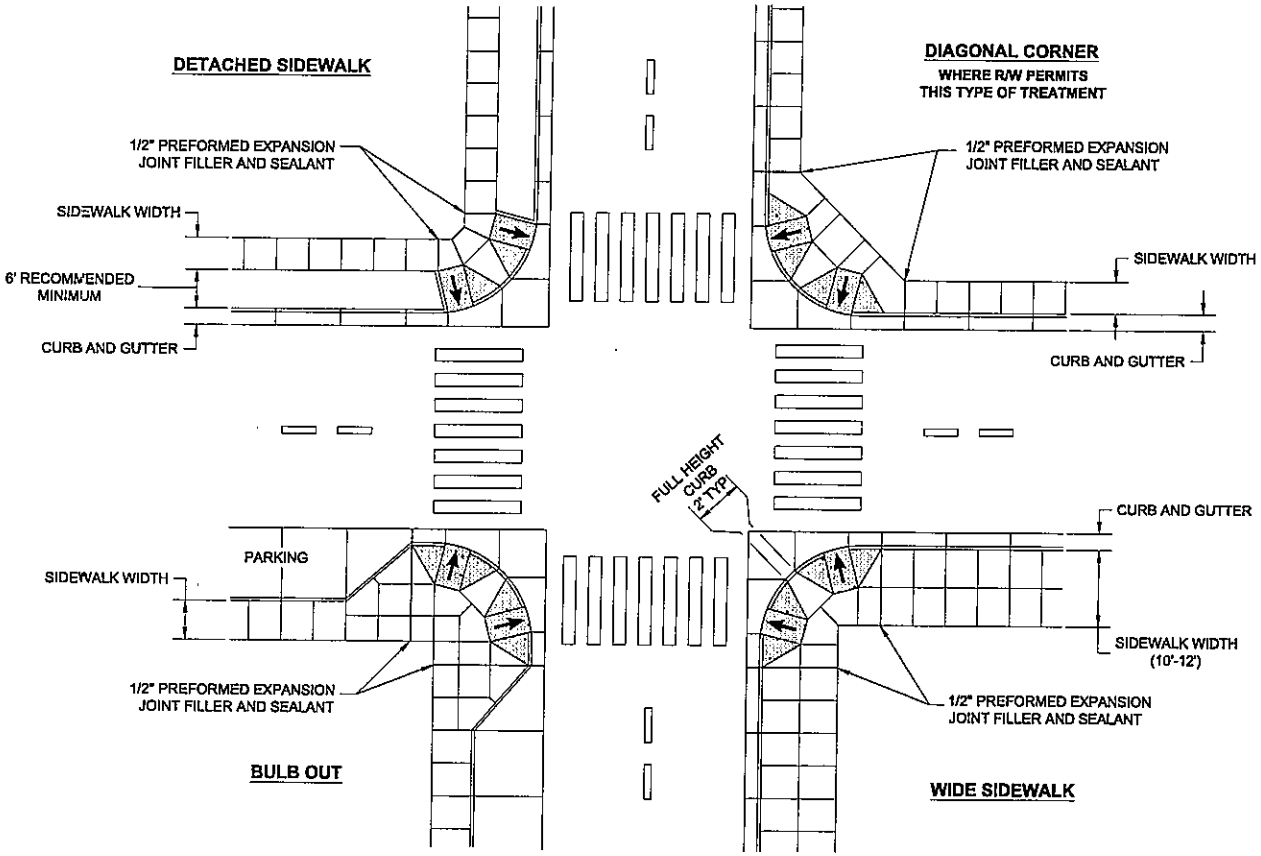
REV.	DESCRIPTION	DATE
1	REDRAFTED ONTO COMPUTER- Z.T.L.	9/1/00
2	DIMENSION CHANGE	6/17/03
3	DRAWING STANDARDS REVISIONS	JAN 06



DETACHED SIDEWALK - BACK TO BACK RAMPS



DIAGONAL CORNER- BACK TO BACK RAMP



TYPICAL CURB RAMP TYPE I TREATMENTS

GENERAL SIDEWALK REQUIREMENTS

SIDEWALKS SHALL BE CONSTRUCTED TO PROVIDE ACCESSIBILITY CONSISTENT WITH THESE SPECIFICATIONS AND ADA STANDARDS UNLESS OTHERWISE SHOWN IN THE PLANS OR DIRECTED BY THE ENGINEER.

MINIMUM SIDEWALK WIDTH SHALL BE 5 FEET WHENEVER POSSIBLE. SIDEWALKS NARROWER THAN 5 FEET SHALL PROVIDE PASSING ZONES SPACED NO GREATER THAN 200 FEET AND MUST BE A MINIMUM OF 5 FEET BY 5 FEET. THE MINIMUM WIDTH FOR AN ACCESSIBILITY ROUTE IS 36".

THE CROSS-SLOPE ON SIDEWALKS AND CURB RAMPS SHALL NOT EXCEED 1:48. ALL SIDEWALKS SHALL BE SLOPED 1:48 TOWARDS THE CURB AND GUTTER UNLESS OTHERWISE INDICATED TO PROVIDE POSITIVE DRAINAGE. SIDEWALKS SHALL PROVIDE A MINIMUM OF 36" CLEAR PASSAGE AROUND DRIVEWAYS AND OTHER FEATURES TO PREVENT EXCEEDING THE MAXIMUM CROSS-SLOPE.

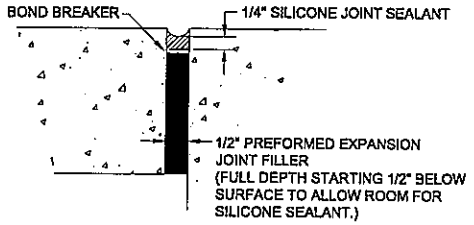
CURB RAMPS SHALL BE PROVIDED AT STREET INTERSECTIONS AND ELSEWHERE AS SHOWN ON THE PLANS. RAMPS SHALL ALSO BE PROVIDED MID BLOCK IN THE VICINITY OF HOSPITALS, MEDICAL CENTERS, ATHLETIC STADIUMS, REST AREAS, DESIGNATED HANDICAP PARKING AREAS AND AT ANY OTHER LOCATION WHERE A CROSSWALK OR WHEELCHAIR ACCESS IS NEEDED AS DETERMINED BY THE ENGINEER.

CURB RAMPS SHALL BE MEASURED AND PAID FOR AS CONCRETE SIDEWALK AND WILL INCLUDE CURB RETURNS AND INTERIOR CURBS. THE AREA OF THE CURB RAMP THAT FALLS ON THE STREET SIDE OF THE BACK OF CURB LINE WILL BE MEASURED AND PAID FOR AS CURB AND GUTTER OR AS DETERMINED BY THE ENGINEER.

STREET DRAINAGE STRUCTURES SHALL NOT BE PLACED IN LINE WITH CURB RAMPS NOR IN THE PATH OF PEDESTRIANS. GRATINGS AND ACCESS COVERS SHALL NOT BE PLACED IN SIDEWALK CURB RAMPS.

SIDEWALKS AND CURB AND GUTTER SHALL BE CONSTRUCTED WITH 1/2" PREFORMED EXPANSION JOINT FILLER AT RADIUS POINTS, JUNCTIONS WITH EXISTING CONCRETE, INTERSECTIONS OF CONCRETE SIDEWALK RUNS, AT THE JUNCTURE OF CURB AND GUTTER AND SIDEWALK WHEN THE STREET PAVEMENT IS CONCRETE, AROUND INLETS, AROUND MANHOLES, AROUND OTHER STRUCTURES AND AT INTERVALS. PREFORMED EXPANSION JOINTS SHALL BE SEALED WITH AN APPROVED SILICONE JOINT SEALANT.

CURB RAMPS SHALL BE TYPE I OR TYPE I MODIFIED UNLESS OTHERWISE SHOWN IN PLANS. IF NO RAMP TYPE IS SPECIFIED AND EXISTING CONDITIONS DO NOT PERMIT ADEQUATE CLEAR RIGHT OF WAY, TYPE II OR TYPE III RAMPS MAY BE INSTALLED DEPENDING ON THE GIVEN SIDEWALK WIDTH.



GENERAL SIDEWALK REQUIREMENTS FOR ADA ACCESSIBILITY

NOT TO SCALE

CITY OF CASPER
ENGINEERING DIVISION

GENERAL SIDEWALK REQUIREMENTS FOR ADA ACCESSIBILITY

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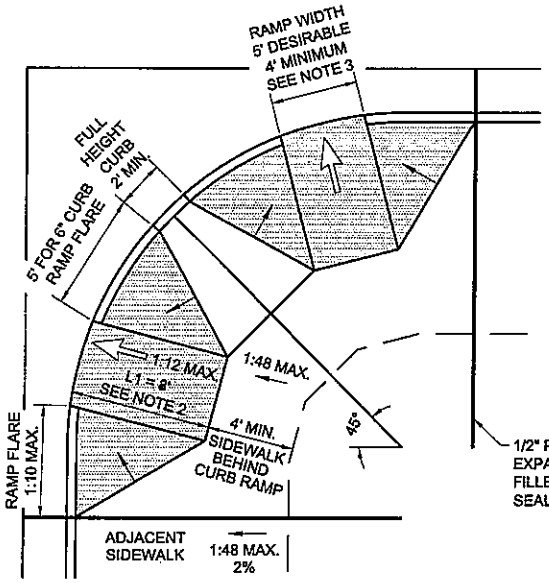
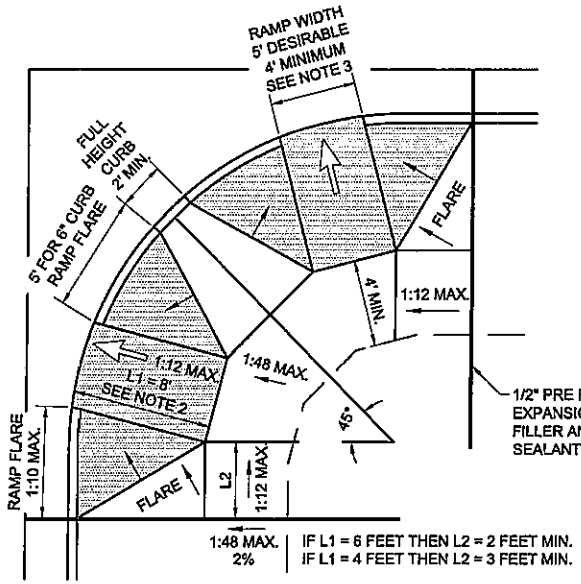
1	REDRAFTED ONTO COMPUTER- Z.T.L.	8/7/01
2	DRAWING STANDARDS REVISIONS	JAN 06

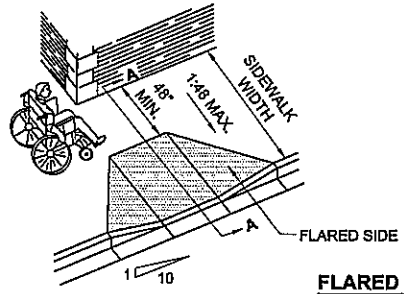


TYPICAL TYPE I (PERPENDICULAR) CORNER RAMPS

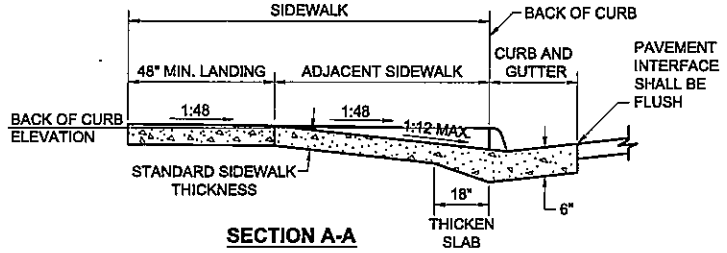


MODIFIED TYPE I (COMBINED) CORNER RAMPS

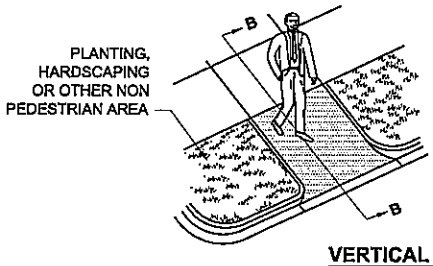
SEE NOTES 2A & 2B



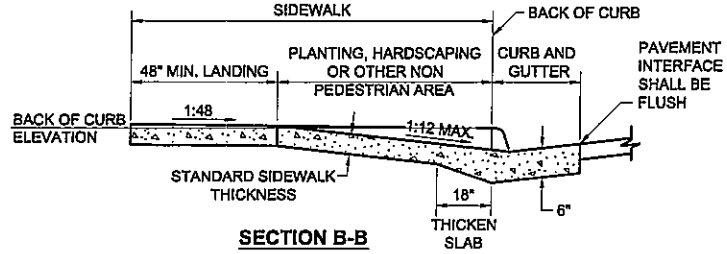
FLARED CURB TREATMENT



SECTION A-A



VERTICAL CURB RETURNS



SECTION B-B

TYPE I (PERPENDICULAR) CURB RAMPS

NOT TO SCALE

TYPE I (PERPENDICULAR) CURB RAMP REQUIREMENTS

TYPE I CURB RAMPS SHALL BE CONSTRUCTED WHEN AVAILABLE RIGHT-OF-WAY PERMITS THEIR USE.

1. **RAMP SLOPE:** THE RAMP SLOPE SHOULD NOT EXCEED 1:12. ADA ALLOWS A MAXIMUM SLOPE OF 1:10 IN EXISTING FACILITIES WHERE A 1:12 IS NOT POSSIBLE AS DEFINED IN ADA AS SITE INFEASIBILITY.

2A. **RAMP LENGTH:** THE RAMP LENGTH BECOMES 8' FOR A 6" CURB WHEN THE RAMP RISES ON A 1:12 TO CATCH THE ADJACENT SIDEWALK WHICH IS ALSO RISING ABOVE THE TOP OF CURB ELEVATION ON A 1:48 CROSS SLOPE. IF A PLANTING OR OTHER NON PEDESTRIAN AREA IS ADJACENT TO THE SIDEWALK AND THE RAMP ONLY HAS TO RISE 6" THE RAMP LENGTH IS 6'.

2B. **RAMP LENGTH:** WARPING THE INTERSECTION USING A COMBINED RAMP SYSTEM REDUCES THE HEIGHT THE RAMP MUST RISE THEREBY REDUCING THE LENGTH OF THE PERPENDICULAR RAMP.

3. **RAMP WIDTH:** PERPENDICULAR RAMPS SHOULD BE 5' WHERE POSSIBLE, 4' IN OTHER LOCATIONS, AND WHERE SITE INFEASIBILITY EXISTS ABSOLUTELY NO NARROWER THAN 3'.

4. **LEVEL LANDINGS:** A LEVEL LANDING (I.E. MAX. SLOPE IN ANY DIRECTION DOES NOT EXCEED 1:48) SHALL BE PROVIDED AT THE TOP OF THE RAMP AND BE 48" MINIMUM IN THE LONGITUDINAL DIRECTION OF THE RAMP TO ALLOW FOR WHEELCHAIRS TURNING ONTO THE RAMP.

5. **FLARED VS VERTICAL CURB RETURNS:** FLARED SIDE RETURNS ARE REQUIRED WHEN SIDEWALK IS LOCATED ADJACENT TO THE RAMP (SEE DETAIL). THE FLARE RATE ALONG THE CURB LINE SHALL NOT EXCEED 1:10. IF THE SIDES OF THE RAMP ARE ADJACENT TO A PLANTING, STRUCTURE OR OTHER NON PEDESTRIAN SURFACE, THE CURB RETURNS CAN BE VERTICAL. CURB RETURNS AND FLARES WILL BE MEASURED AND PAID FOR AS SIDEWALK.

6. **DIAGONAL VS DUAL CURB RAMPS:** SINGLE DIAGONAL WHEELCHAIR RAMPS FOR INTERSECTIONS WITH TWO DIRECTIONS OF PEDESTRIAN MOVEMENT TEND TO CREATE MORE MOTOR VEHICLE CONFLICTS WITH PEDESTRIANS AND ARE DISCOURAGED. SITE INFEASIBILITY CONDITIONS MAY DICTATE A SINGLE DIAGONAL WHEELCHAIR BUT IS ONLY PERMITTED WHERE SHOWN IN THE PLANS OR DETERMINED BY THE ENGINEER.

7. **INTERSECTION LOCATION:** CURB RAMPS SHALL BE LOCATED AS CLOSE TO THE INTERSECTION AS POSSIBLE AND SHALL BE FULLY CONTAINED WITHIN PEDESTRIAN CROSSING MARKINGS WHERE PRESENT. CURB RAMPS SHALL BE PERPENDICULAR TO THE CURB AS SHOWN.

8. **COLORED CURB RAMPS:** SHADED AREAS REPRESENT WHERE COLORED CONCRETE IS REQUIRED TO PROVIDE CONTRAST. FOR TYPICAL "GREY CONCRETE", CURB RAMPS SHALL BE COLORED WITH RED PIGMENT IN THE CONCRETE UNLESS OTHERWISE SHOWN IN PLANS.

CITY OF CASPER
ENGINEERING DIVISION

TYPE I PERPENDICULAR CURB RAMPS FOR ADA ACCESSIBILITY

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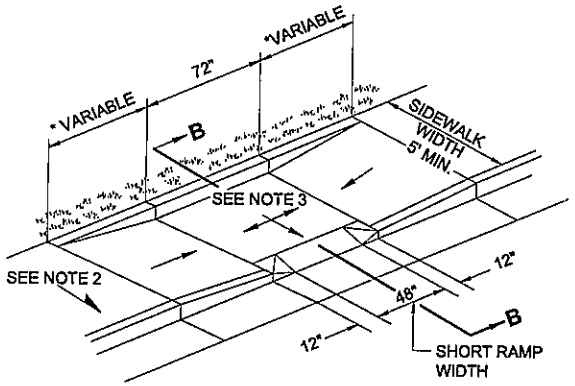
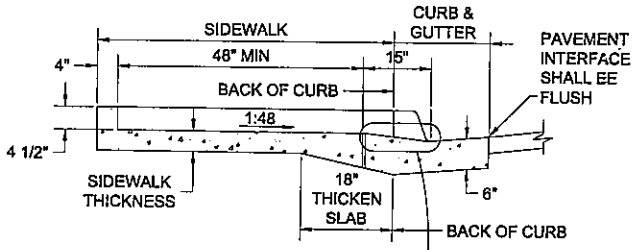
1	REDRAFTED ONTO COMPUTER- Z.T.L.	8/13/01
2	DRAWING STANDARDS REVISIONS	JAN 06



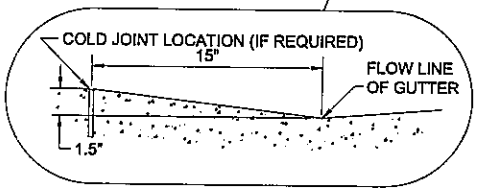
* VARIABLE LENGTH BASED ON RUNNING SLOPE OF SIDEWALK.
FOR FLAT CONDITIONS AND CURB HEIGHT = 6":
ELEVATION OF FLOW LINE = 0"
ELEVATION OF LANDING = 1.5"
RISE OF PARALLEL RAMPS = 4.5"
VARIABLE DIMENSION = 4.5'

CURB RAMP TYPE II

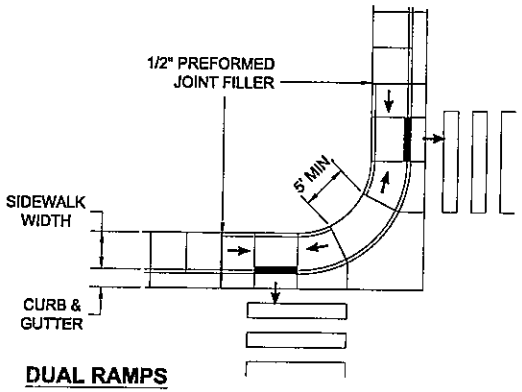
(MODIFIED PARALLEL CURB RAMP)



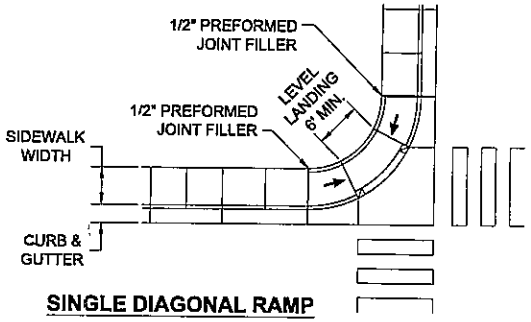
SECTION B-B



SHORT RAMP DETAIL



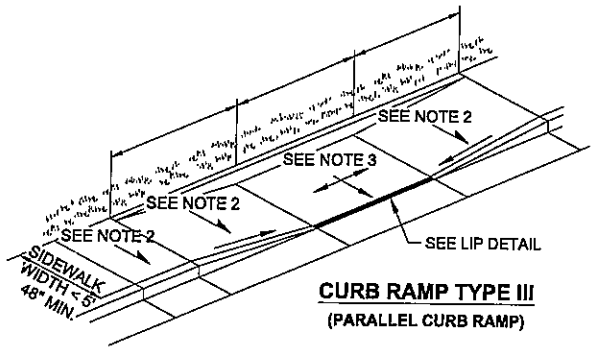
DUAL RAMPS



SINGLE DIAGONAL RAMP

TYPICAL CURB RAMP TYPE II & TYPE III TREATMENTS

(TYPE II RAMPS SHOWN)
FOR SIDEWALK WIDTHS 5' AND GREATER - USE TYPE II
FOR SIDEWALK WIDTHS LESS THAN 5' - USE TYPE III



CURB RAMP TYPE III

(PARALLEL CURB RAMP)

TYPE II & TYPE III (PARALLEL) CURB RAMP REQUIREMENTS

TYPE II AND TYPE III (PARALLEL) CURB RAMPS SHALL BE CONSTRUCTED ONLY WHEN EXISTING SIRE CONDITIONS DO NOT PERMIT THE USE OF TYPE I OR TYPE I MODIFIED CURB RAMPS. TYPE II AND III RAMPS ARE LESS DESIRABLE DUE TO STRAINED TURNING MOVEMENTS IN WHEELCHAIRS AND DRAINAGE (INCLUDING ICING) PROBLEMS ASSOCIATED WITH THE LANDING AREA.

1. **RAMP SLOPE:** RAMP SLOPE SHALL BE 1:12. RAMP SLOPE SHALL NOT EXCEED 1:12 EXCEPT FOR SHORT RAMPS AS SHOWN HEREIN.

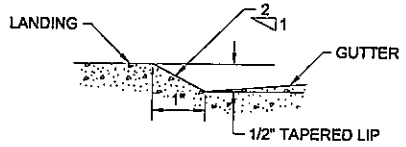
2. **CROSS SLOPE:** POSITIVE DRAINAGE SHALL BE PROVIDED BY SLOPING SIDEWALK AND/OR RAMP TOWARDS STREET AT 1:48. CROSS SLOPE SHALL NOT EXCEED 1:48.

3. **LANDING SLOPE:** LANDING SLOPE SHALL NOT EXCEED 1:48 IN ANY DIRECTION. POSITIVE DRAINAGE SHALL BE PROVIDED TOWARDS THE STREET AS SHOWN BY SINGLE TIP ARROW. LANDING CAN BE SLOPED IN EITHER DIRECTION TO A MAXIMUM OF 1:48 AS SHOWN BY DOUBLE TIP ARROW.

4. **SINGLE DIAGONAL VS. DUAL CURB RAMPS:** DUAL CURB RAMPS ARE STRONGLY PREFERRED, HOWEVER, WITH TYPE II AND TYPE III RAMPS, IT MAY BE NECESSARY AT SOME LOCATIONS TO PROVIDE ONLY ONE SINGLE DIAGONAL RAMP AS SHOWN IN THE PLANS OR AS DIRECTED BY THE ENGINEER.

5. **COLORED CURB RAMPS:** SHADED AREAS REPRESENT WHERE COLORED CONCRETE IS REQUIRED TO PROVIDE CONTRAST. FOR TYPICAL "GREY CONCRETE" CURB RAMPS SHALL BE COLORED WITH A RED PIGMENT IN THE CONCRETE UNLESS OTHERWISE SHOWN IN THE PLANS.

6. **LIP DETAIL:** TYPE III CURB RAMPS WILL REQUIRE THE FOLLOWING LIP DETAIL TO REDUCE THE AMOUNT OF NUISANCE DRAINAGE IN THE LANDING AREA.



LIP DETAIL

TYPE II & TYPE III (PARALLEL) CURB RAMPS

NOT TO SCALE

CITY OF CASPER
ENGINEERING DIVISION

TYPE II & TYPE III (PARALLEL) CURB RAMPS FOR ADA ACCESSIBILITY

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1	REDRAFTED ONTO COMPUTER- Z.T.L.	8/15/01
2	DRAWING STANDARDS REVISIONS	JAN 06